THE IMPACT OF CLIMATE CHANGE ON RURAL LIVELIHOODS IN THE NORTH NGUU MOUNTAINS, KILINDI DISTRICT, TANZANIA

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by the Open University of Tanzania a thesis titled **'The Impact of Climate Change on Rural Livelihoods in the North Nguu Mountains in Kilindi District, Tanzania'** in fulfillment of the requirements for the degree of Doctor of Philosophy (PhD) of The Open University of Tanzania.

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DECLARATION

I, Peter John Mjata do hereby declare that, this dissertation is my own work and has never been and will not be submitted for certification in any other university or higher learning institution.

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DEDICATION

This thesis is dedicated to my wife Nemganga and our four boys Mgalu, Mkomwa, Msami and Chonde.

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I would like to extend my sincere thanks to my family especially my wife Nemganga and our sons Mgalu, Mkomwa, Msami and Chonde for patience during my study. Many individuals and institutions contributed to the success of this study. I am very grateful to Prof. Paul Maro from the Geography Department, College of Arts and Social Science of the University of Dar es Salaam and Dr. Magreth Bushesha from The Open University of Tanzania for their guidance during my study. Special thanks goes to Prof. Dr. Ir. Bert Bruins and Prof. Dr. Henk Ritzema from the Centre for Water and Climate: Irrigation and Water Engineering Group of Wageningen University in the Netherlands for their valuable and useful information on climate change and rural livelihoods. I also appreciate the rich and informative discussions with Prof. Joseph Mbwiliza, Prof. H. Rwegoshora, Dr. Jumanne D. Kalwani, Dr. S. Waane, Dr. John P. A. Msindai and Dr. Warren Reed from The Open University of Tanzania for their support and professional guidance when conducting this study.

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ABSTRACT

This study was set to investigate the impact of climate change on rural livelihoods in the North Nguu Mountains in Kilindi District, Tanzania. Objectives of the study were to assess people's perceptions on the relationship between climate change and livelihoods; to analyze the influence of climate change on people's daily living and to examine potential of the forest for adapting to climate change. The conceptual model for this study was modified from the comprehensive conceptual model for disaster management by Kelly, (1998) with ideas on climate change, the forest and livelihoods from Burges, (2000); Groot *et al.,* (2002) and Heal *et al.,* (2004). Data was collected through interview, focus group discussions, observations and documentary review. A simple descriptive statistical approach using content analysis were applied for data analysis. The impact of climate change on livelihoods in The North Nguu Mountains was revealed to include pressure on the forest (47.8%); unsustainable production and productivity of the forest (29.8%); unsustainable livelihood systems and options for adaptation (14.6%) and income poverty (7.8%). The rich mountain-top natural forests base was a potential livelihood asset (93.2%). Food insecurity and income poverty contributes to unsustainable livelihoods (94.7%). The study recommends diversification of livelihoods parallel to sustaining the economic, ecological and social structures for rural livelihoods. The conceptual framework for this study succeeded in generating information on intensification of the detrimental effects of climate change resulting to deterioration of the forest (as the main livelihood asset) hence poor resilience and mitigation portfolios leading to unsustainable livelihoods as set out in the main focus of the study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF TEXT BOXES

ACRO0NYMS AND ABBREVIATIONS

ADMADE	Administrative Design for Game Management Areas
AWF	African Wildlife Foundation
BT	Bench Terraces
CAMPFIRE	Communal Areas Management Programme for Indigenous Resources
CARE	Committment, Accessibility, Respect, Effectiveness
CBD	Convention on Biological Diversity
CBFM	Community Based Forest Management
CBO	Community Based Organization
CFR	Catchment Forest Reserve
COD	Cut Off Drain
CoP	Conference of Parties
DNPWLM	Development of National Parks and Wildlife Management
DRR	Disaster Risk Reduction
EWS	Early Warning System
FBD	Forest and Beekeeping Division
FGD	Focus Group Discussion
FJT	*Fanya Juu* Terraces
FR	Forest Reserve
GDP	Gross Domestic Product
HIAP	Handeni Integrated Agroforestry Project
HP	Hima Pradesh

IBA	Important Bird Area
ICBP	International Centre for Birds of Prey
IISD	International Institute for Sustainable Development
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
JFM	Joint Forest Management
KDC	Kilindi District Council
MBCA	Menai Bay Conservation Area
NAP	National Action Programme to Combat Desertification
NAPA	National Adaptation Programme of Action
NAWAPO	National Water Policy
NBSAP	National Biological Diversity Strategy and Action Plan
NEMC	National Environmental Management Council
NEP	National Environment Policy
NFP	National Forest policy
OECD	Organisation for Economic Co-operation and Development
OHVN	*Office de la Haute Vallée du Niger*
RDC	Rural District Councils
REPOA	Research on Poverty Alleviation
SECAP	Soil Erosion Control and Agroforestry Project
SPSS	Statistical Package for Social Sciences
SWC	Soil and Water Conservation
T&NT	Timber and Non-Timber

TFCG	Tanzania Forest Conservation Group
TMA	Tanzania Meteorological Agency
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
URT	United Republic of Tanzania
US-EPA	United States Environmental Protection Agency
WINDFALL	Wildlife Industry's New Development for All

CHAPTER ONE
1.0 INTRODUCTION

1.1 Background to the Research Problem

Changes to natural ecosystems affect climate parameters (Mansourian *et al.* 2009; Reid, 2004). A change in the climate parameters sometimes referred to as the changing climatic conditions is a deviation in weather conditions of a given area over an extended period due to both natural variability and anthropogenic processes (FAO 2007). The anthropogenic processes on climate change results mainly from the human influence (IPCC, 2001a).

The impact of climate change include biodiversity loss (particularly the forest) and land use changes (IPCC, 2007; US-EPA, 2009). In the meantime, forests play a critical role in reduction of emissions but also provision of income, food, medicine, tools, fuel, fodder, construction materials and so on (Reid, 2004). Nevertheless, potential of the forest (bio-mass) is measured in terms of its ecological naturalness, environmental benefits, capability and health (IUCN, 1999). Poor people are therefore severely affected when the environment is degraded. Climate change therefore threatens the livelihoods of poor people (Smith & Troni, 2004; Reid 2004). The common livelihood features in Africa under the changing climatic conditions include among others, livelihood diversification (Morton, 2007; Carney, 1998).

However, many defining features of livelihoods in the continent are commonly regarded as adaptive options (Carney, 1998; Tyler & Fajbar 2009). Tanzania is rich

in forests (URT, 2000). For about 338,000 km^2 which is approximately 44% of the total land area of the country, is under forest providing an important livelihood asset for a large number of Tanzanians (Kingdon & Howell, 1993; World Bank, 2002). Most of the natural forests in Tanzania were gazetted as forest reserves mostly for biodiversity conservation and production purposes including water catchment (Missana, 1991). Cutting down or burning forests, for example, increases emissions currently thought to be 1.1 to 1.7 billion tons per year affecting livelihoods mostly of people with limited capacity for adaptations (Carney, 1998; Walter & Simms 2002; Huq *et al.* 2003; Sperling 2003; Reid, 2004).

Forming part of the Eastern Arc Mountains in Tanzania, the North Nguu Mountains are a succession of natural forest-top mountains that are paramount for economic, social and cultural roles (UNEP, 2001; Kingdom & Howell, 1993). Small scale mining is rampant in Kilindi district, particularly in the North Nguu Mountains where prospectors operate individually in very low scales and poor conditions. Meanwhile, covering 2,605.7 km^2 North West of the North Nguu Mountains is a game controlled area (HDC, 2000; HIAP, 2000). Generally, the forest in the North Nguu Mountains play important economic, social, and cultural roles by providing goods and services from the forest ecosystem, water through the rainfall moderation function, room for hunting including bee hunting, as well as, room for traditional ritual ceremonies (KDC, 2000; HIAP, 2000; UNEP, 2001; Agrawala, *et al.*, 2003). Besides the normal hunting and gathering processes inside the rich natural forests by local communities in the North Nguu Mountains, forest encroachment and destruction was on an increase during the late 1990's (KDC, 2000). It was common

for crop farmers to clear the forest for crop-farming and the pastoral communities taking cattle herds inside the forest for pasture and water (KDC, 2000; HIAP, 2000). However, the country introduced new forms of forest management and profit sharing through the Joint Forest Management – JFM (2000) and Community Based Forest Management – CBFM (2000). Such arrangements provided the people with access and user rights to the forest as motivation to enhance their involvement and commitment to forest management that is linked with improving their livelihoods.

But given the accelerating long term changing weather conditions in the area, it becomes too difficult for communities, for example, to predict when exactly it will rain or when there will be drought and how long will the rain or drought last. This situation compel people to unpredictable and unsustainable crop farming, reliable products and services from the forest, as well as, favourable conditions for the nomadic agro-pastoral systems in the area (HDC, 2000; HIAP, 2000). This study was therefore set to find why despite the forest potential and the policy level frameworks for access and profit sharing with the other stakeholders, still communities in the North Nguu Mountains are compelled to unsustainable livelihoods.

1.2 Statement of the Problem

Forests can make significant contributions to rural livelihood portfolios by providing opportunities for livelihood diversity and security (Morton, 2007; Carney, 1998). The North Nguu Mountains area is endowed with fertile land, forests and wildlife (KDC, 2000; HIAP, 2000). The natural scenario of the forest together with wildlife provides high biodiversity with critical watersheds for life support systems and are of

economic mainstay in the area (IUCN, 2002; NEMC, 2006). Moreover, the Community Based Forest Management – CBFM (2000), the Joint Forest Management – JFM (2000) and the Participatory Wildlife Management (2000) arrangements provides legal access and user-rights to communities in managing and sharing of benefits from the forest and wildlife resources in the area.

However, protecting the forest and game resources by creating 'Forest Reserves' and a 'Game Controlled Area' takes away the access (user-rights) and benefits from communities living within the vicinity of the resources in the area. Moreover, the changing climatic conditions over an extended period makes it difficult for communities in the area to predict, for example, when it will rain, when there will be drought and how long will the rain or drought last (KDC, 2000; HIAP, 2000). Despite the forest potential and the participatory frameworks for access and benefits from the forest and game, communities in the North Nguu Mountains in Kilindi district, Tanzania are still compelled to unsustainable livelihoods.

1.3 Objectives of the Study

The general objective of this study was to examine the impact of climate change on the forest linked rural livelihoods within the North Nguu Mountains. Specific objectives of this study were:

a) To assess people's perceptions on the relationship between climate change and livelihood systems in the North Nguu Mountains.
b) To examine the influence of climate change on people's daily living in the North Nguu Mountains.

c) To evaluate potential of the forest for adapting to climate change in the North Nguu Mountains.

1.4 Research Questions

Research questions for this study were focused at establishing knowledge on the impact of climate change on forest linked livelihoods within the North Nguu Mountains. Specific research questions for this study were:

a) How do communities in the North Nguu Mountains perceive climate change with respect to their livelihoods?
b) How does the changing climatic conditions influence people's daily living in the North Nguu Mountains?
c) What are the potentials of the forest in adapting to climate change in the North Nguu Mountains?

1.5 Significance of The Study

The overall long-term goal of socio-economic development for Tanzania by the year 2025 is to attain sustainable human development with all the prerequisites for achieving a fully developed economy (URT, 2002). The study on the impact of climate change on the forest rural livelihoods within the North Nguu Mountains develops knowledge on climate change and the mountain forest ecosystems; it creates knowledge on biodiversity and the allied natural ecosystems that link mountain areas as potential assets for sustainable livelihoods and options for adaptation as a hedge against climate change. Specific significance of this study is the addition of valuable and useful information to the growing literature on

sustainable forest linked rural livelihoods for local communities in the North Nguu Mountains including stakeholders of the forest and community development with a particular focus on climate change and sustainable livelihood initiatives. The study initiated and provided basic information necessary for conducting further studies on climate change, sustainable rural livelihoods and the forest resource. Nevertheless, results from this study adds valuable information to the appraisal of both the Comprehensive Conceptual Model for Disaster Management (Kelly, 1998) used in this study parallel to the Power and Participatory development model: Theory and Practice by Nelson *et al.*, (Editors), 1995.

1.6 Limitations

1.6.1 Values of goods and services from the forest ecosystem (as mentioned by communities) were not measured into monetary terms when conducting this study.

1.6.2 There exist a long term general accusation in the area that whatever rural communities do on protected forests 'Forest Reserves' for their living is considered destructive and illegal. This created fears to local communities during discussions.

1.6.3 There exist also game linked livelihoods that form part of the forest rural livelihoods in the study area. However, this study considered such systems to be part of or directly linked to the forest rural livelihoods.

1.6.4 Seeking information from women was not very easy due to the background (social cultural conditions) of the local people in the study area.

Nevertheless, information generated through this study should be considered sufficient, important and worth noting.

1.7 The Conceptual Framework

Generally, forests are of economic, social and environmental importance constituting life support systems at local and broader levels i.e. the forest ecosystem assets that consists of structures and functions of the forest provides goods and services that consists use and non-use values. The values of goods and services from the forest ecosystem are of consumption and non-consumption uses where the non-consumption use values can be attained directly or indirectly (Burges, 2000).

However, climate change creates pressure on the forest thus weakening the ecological production function of the forest (Groot *et al.,* (2002) and Heal *et al.,* (2004). This study therefore converge ideas from Burges, (2000), Groot *et al.*, (2002) and Heal *et al.,* (2004) to the comprehensive conceptual model for disaster management as applied by Kelly (1998). This gives some focused ideas on a descriptive link on a flow of goods and services from the forest ecosystem in connection to rural livelihoods and climate change.

Generally, the model used in this study establishes a link between climate change, and rural livelihoods through the forest (as a livelihood asset). The model illustrate insufficient capital, policies and technology combined with adverse conditions resulting from climate change leading to unsustainable livelihoods hence poverty. The situation increases emissions intensifying further climate change. Figure 1.1 presents the conceptual framework for the impact of climate change on rural livelihoods modified from the comprehensive conceptual model for disaster management as applied by Kelly (1995) as applied in this study.

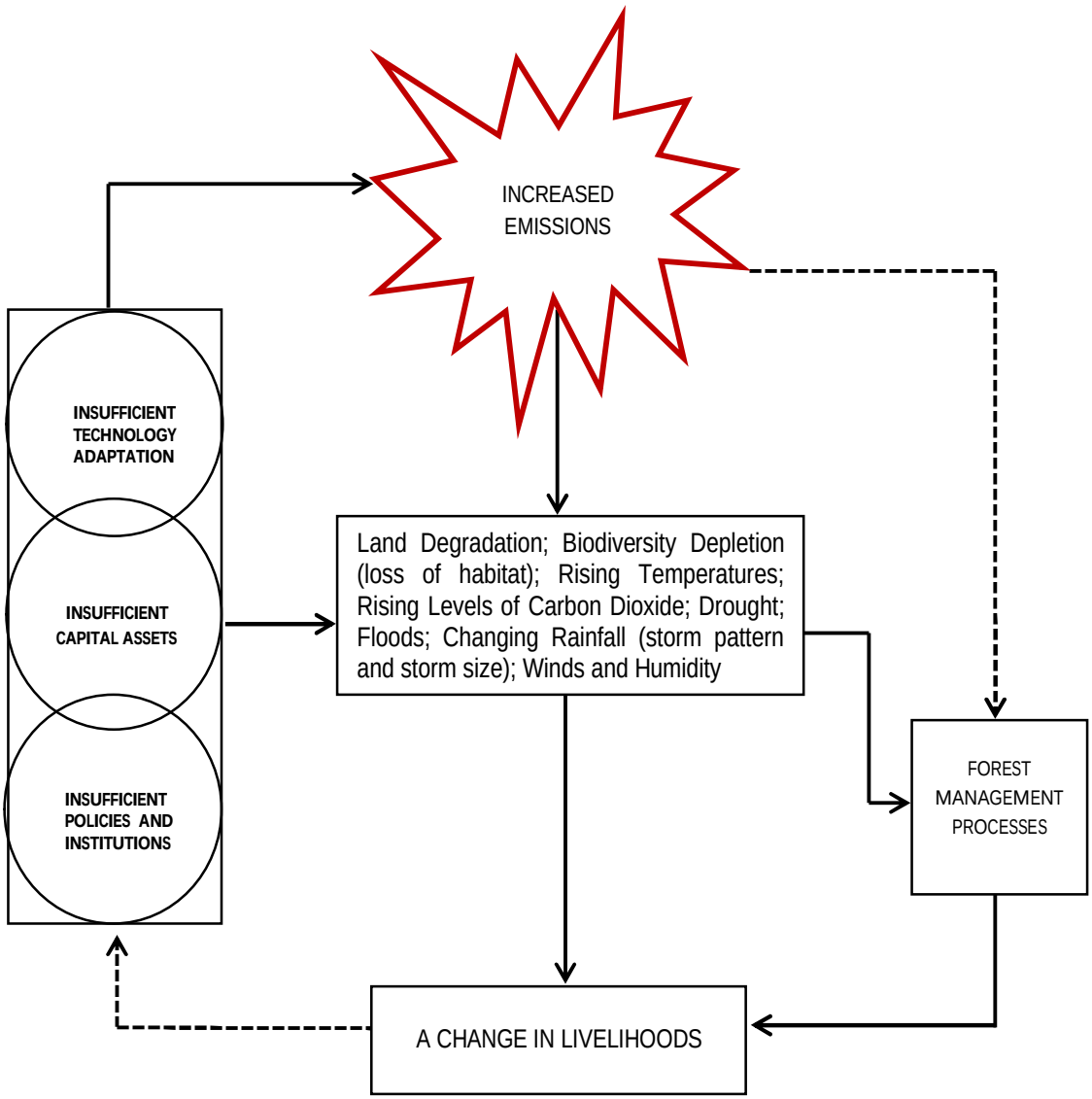

Figure 1. 1: The conceptual framework for the impact of climate change on rural livelihoods

Source: Modified from Kelly (1998).

1.8 Organization of the Thesis

This thesis is organized in eight chapters. Chapter one introduces the study giving some background to the research problem, it gives statement of the problem, objectives of the study, research questions, significance of the study and its

conceptual framework. Chapter two gives the reviewed literature whereas, Chapter three gives description of the study area, the study sample and the methodology used in conducting this study. It presents further the tools used in data collection and data analysis. Chapter four presents the results with detailed discussions on local people's perception on the relationship between climate change and livelihood mechanisms in The North Nguu Mountains. Chapter five presents the results and discussions on instrumental records – rainfall data. Chapter six presents the results on the impact of climate change on livelihoods in The North Nguu Mountains. Chapter seven presents results on existing options for adaptation for climate change in The North Nguu Mountains and Chapter eight present summary, conclusions, implications and recommendations from the study.

CHAPTER TWO
2.0 LITERATURE REVIEW

2.1 Introduction

Reviewed literature for this study include theoretical and empirical data together with policy statements and narrative accounts at global and national levels on the growing concern about climate change and livelihoods. More focus is vested on issues that necessitated Tanzania to take part in a series of global conferences focused at devising some means of reducing human influence on the climate and to formulate ways of exploiting the climate for social and economic benefits (IPPC, 2001).

2.2 Definition of Key Concepts

2.2.1 Climate change

Climate change is a change in the statistical distribution of weather patterns that lasts for an extended period of time. It refers to a change in average weather conditions or variation of weather around long-term average conditions (Schmidt, 2004). Similarly, climate change depicts permanent gradual processes on the deviation of weather conditions of a given area over an extended period of time (FAO, 2007). The current global warming (rot of climate change) is described to be the result of human activities particularly those related to industrial consumption and land use practices (IPCC, 2007). The impact of climate change is likely to severely damage social and economic systems of most developing countries including Tanzania (IPCC, 2001a; IISD, 2008). Generally, climate change is conceptually resulting from human activities that change composition of the atmosphere causing severe damage to

natural, social and economic systems (US-EPA, 2009; IPCC, 2001a; IPCC, 2007; Brown and Crawford, 2008). Cutting down or burning forests, for example, increases emissions currently thought to be 1.1 to 1.7 billion tons per year affecting mostly people with limited adaptation options (Huq *et al.* 2003; Sperling, 2003; Reid, 2004). Moreover, Climate change is referred to as a significant and lasting change in the statistical distribution of weather patterns over periods (Reid, 2004). However, the definition of climate change in this study is restricted to the long term changing weather conditions induced by the human (IDRC/CCAA, 2009).

2.2.2 Adaptation

According to Reid *et al.* (2004) and Mansourian *et al. (*2009), adaptation refers to natural reactions that develop in response to imposed conditions and furthermore, it reflects to strategies for adjustments that are designed to reduce or recover from risks associated with changing climatic (environmental) conditions. Furthermore, adaptation denotes forms of collective conduct that aim at achieving modifications in the ways in which society relates to nature and nature to society.

However, Lodha, (2010) refers adaptation as a change in structure, function or form that produces better adjustments to physical and cultural environments. Adaptation in this study therefore refers to the integration of efforts to support vulnerable rural communities in adapting to the impact of the changing climatic conditions by supporting them to be aware and get informed, analyze risk, plan for change and adopt to innovative resilient livelihood systems by identifying and targeting strategies based on the available resources i.e. the livelihood assets and community's needs and priorities for specific localities.

2.2.3 The forest

A forest is a complex ecosystem made up of both living things such as trees and birds, and non-living things such as fallen logs, water and rock that form dynamic units whose composition changes over time as a result of interacting and living together (Larson et al. 2007). However, according to Siry et al. (2009), all living things in the forest are part of a huge, complex and interacting web of life and each living thing has its role in the health and growth of a forest. Meanwhile, Lodha, (2010), refers the forest as a tract of woodland or a type of biome in which the dominant plants are trees. But the forest in this study refers to a bunch of trees including all living and non-living things that are closely linked with the meteorological and hydrological ecosystem functioning in an area i.e. support as game habitat, fire behavior and tree regeneration processes in the area.

2.2.4 Rural livelihoods

According to Chambers and Conway (1991), livelihood comprises of the capabilities, assets and activities required for people's means of living. It further refer to the means needed to support people's daily living including the course of human events and activities (processes) that supports human living. Furthermore, rural livelihoods refers to the course of human events and activities (processes) that supports human living (Hussein, 2002). Rural livelihoods in this study refers to the forest linked livelihoods (particularly on adapting to disaster i.e. for adaptive capacity, livelihood diversity and security, as well as, enabling environment for people's daily living) to areas close to the forest. Generally therefore, rural livelihoods refers to the course of human actions required as means of living in the rural areas.

2.2.5 Local community

A local community is a group of individuals that interact within their immediate surroundings and their interactions can include the sharing of resources, information and assistance. It is a group of interacting people sharing an environment with intent, belief, resources, preferences, needs, risks, and a number of other conditions that may be common in the area affecting the identity of the participants and their degree of cohesiveness (Chambers and Conway, 1991). Moreover, a local community refers also to a group or groups of people (individuals, families or households) who share a physical space and sometimes have common interests (Sectoral policy document of Development Cooperation No. 8; 1995). The local community in this study refers to the dominant community living in The North Nguu Mountains that include '*Wamasai'* the nomadic pastoral community and '*Wanguu'* who mainly practice subsistence crop farming.

2.3 Review of Literature

2.3.1 Theoretical literature review on climate change and rural livelihoods

Ecosystem structures and functions make ecosystem assets that through interaction with the human produce ecosystem goods and services for livelihoods, economic growth and support to poverty reduction (Rudolf de Groot *et, al.*, 2002, Heal, *et al., 2004)*. According to UNEP (2005), the world's poor depend critically on healthy ecosystems for their livelihoods i.e. their living including adaptation to climate change is directly linked to sustainable use of natural resources. Climate change affects natural resources such as land and biodiversity whereas, changes to natural ecosystems affect climate parameters (Mansourian *et al.* 2009; Reid *et al.* 2004).

Projections indicate that Africa is likely to be affected more severely by climate change due to the continent's heavy dependence on agriculture and limited capacity to adaption (Collier, 2008; Deresa & Hassan 2009). The enormous effects of climate change on the African continent are compounded by the greater vulnerability of its economy, for example, tourism, crop production and livestock keeping to climatic variation (Collier, 2008).

Climate change is dramatically affecting livelihoods of the poor just because such people are often heavily dependent on climate sensitive sectors such as agriculture and livestock while they have limited financial, institutional and human capacity to anticipate and respond to the direct and indirect impacts of climate change (Walter & Simms 2002; Huq *et al.* 2003; Sperling 2003; Tyler & Fajbar 2009). Poor people are therefore, severely affected when the environment is degraded or their access to it is restricted. This is due to the fact that poor people generally depend more on ecosystem goods and services for their livelihoods (Smith & Troni 2004). Any impact that climate change has on land and the biodiversity will therefore threaten the livelihoods, food intake and health of poor people (Reid 2004). Climate change is expected to cause species to migrate to areas with more favourable temperatures and precipitation (IPCC 2002). There is a high possibility that competing and invasive species more adapted to a new climate will move in and such movements could leave some protected areas with a different habitat and species assemblage than they were initially designed (Mansourina *et al.* 2009). By virtue of their importance as habitats, forests are integral to conserving biological diversity and ecosystems with provision of livelihoods (UNEP, 2001; Agrawala, *et al.,* 2003).

Forests are a major store of carbon and play a critical role in the reduction of carbon emissions such that when forests are cut down or burnt, carbon dioxide is released to the atmosphere a situation currently thought to be responsible for annual emissions of 1.1 to 1.7 billion tons of carbon emissions per year affecting mostly people with limited adaptation options (Carney, 1998; Walter & Simms, 2002; Huq *et al.* 2003; Sperling, 2003; Reid, 2004). The 1995 Convention on Biological Diversity - CBD in Jakarta, Indonesia, considered a number of general issues related to forests and highlighted that forests and forest biological diversity play important economic, social, and cultural roles including habitat for wildlife (UNEP, 1995).

Forests can play a role in adaptation by helping human societies to stabilize resilience capacity in adapting to climate change (FAO 2007). Forests may also serve as a source of resilience by providing resources to local populations and through forest land scape, design to protect communities from increasingly erratic weather hence contributing to both global and local mitigation portfolios (Larson *et al.* 2007). However, challenges in the use of forests for climate change mitigation range from developing effective forest carbon sequestration rules (through regeneration and growth of forests) to compliance requirements, market considerations, efficient approach to land use management and performance (Siry *et al.* 2009).

The 1997 Kyoto Protocol for example recognizes clearly the role that forests and forest management play in reducing carbon dioxide emissions, it also places several restrictions on how this can be achieved. These restrictions are related to the principles of baseline, permanence, additionality and leakage far beyond the Kyoto

Protocol e.g. only forests established after 1990 are eligible for carbon offsets. Several other trading schemes assume the same base date as baseline. Nevertheless, by nature, forest carbon sequestration is temporary (Siry *et al.* 2009). Forest carbon sequestration is one of the key approaches to reducing atmospheric carbon concentrations. Forestry, therefore, help to mitigate climate change through afforestation, reforestation, avoided deforestation, silvi-cultural change, biofuels and carbon storage in wood products (Siry *et al.* 2009).

However, despite forests contribution in the enhancement of resilience capacity to both human and natural systems, forest ecosystems may not be able to adapt to the rate of temperature change or the intensity of weather events and other effects such as fire or floods (IIED 2009). According to White (2002), given the strong relationship between the forest and climate change, there have been intensive investments into managing the forest resource as diversified adaptation strategies to benefit more with a regular supply of goods and services from the forest ecosystem. The interventions that were focused at improving the contribution of forests in the enhancement of resilience capacity to both human and natural systems include:

a). France

Payments for water quality. Perrier Vittel's is a large water bottling company that has undertaken two schemes. The company subsidizes the adoption of best management practices for cattle ranching and forest management among landholders who live around the springs that the water bottling plant depends on. The company also subsidizes an organic vineyard to protect the springs.

b). Australia

Irrigators finance upstream reforestation and water transpiration credits earned by state forests of New South Wales for reforestation sold to irrigators. The State forests engage in Large-scale reforestation, including planting of desalination plants, trees and other deep-rooted vegetation in order to reduce water salinity and make the water suitable for domestic use, agriculture and livestock.

c). Colombia

Introduction of environmental services tax (Eco-Tax) for watershed management. The objective is to pay for improved forest management of forests so as to obtain regular water flow for industrial uses, regularity and water purity for drinking payments to private land owners and municipalities that manage forests.

2.3.2 Empirical literature review on climate change and rural livelihoods

Review of literature on empirical cases that took and continue taking place in conserving biological diversity and ecosystems for livelihoods and or adaptation to climate change indicate more benefits from regular supply of goods and services from the biological diversity and ecosystems. The power and participatory development model illustrates a social process that embodies sharing of knowledge for action taking (Nelson *et al.,* 1995). It specifies further that public participation plays a central role in collective actions.

Figure 1.2 presents the power and participatory development model by Nelson *et al.,* (1995) as applied in this study.

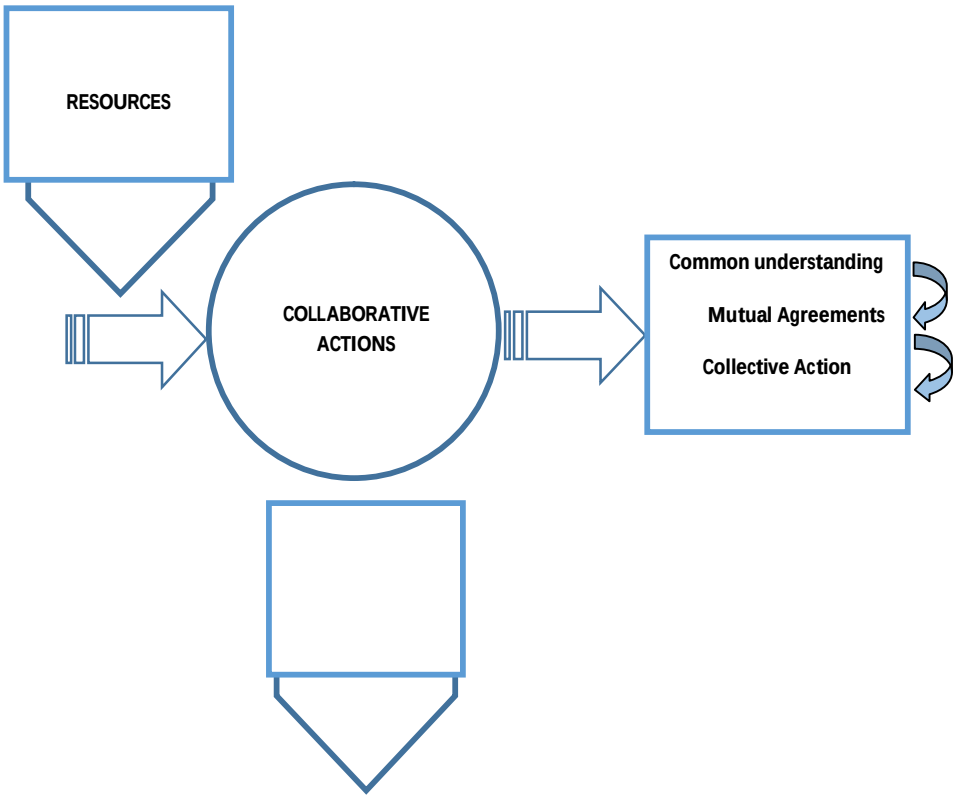

Figure 1. 2: Power and Participatory Development Model.

Adopted from Nelson *et al., Eds* (1995)

A study by Gordana (2009) carried in Europe, Asia and Latin America, for example, indicate that the Prespa Park region connecting Macedonia, Greece and Albania in Europe was becoming under threat of soil, water contamination and land erosion resulting to loss of forest-cover annually. Degradation of the park's natural resources was due to adaptations to climate change. The situation has affected livelihoods in the area. Experience was drawn from extended field research and case studies. Though no mention of paradigms models and theories developed through the Prespa Park study, still the methodology and approaches used i.e. visiting families, tourists and the business community were useful and hence worth noting.

According to Gouri (2004), forests are critical to the livelihoods of most people in Himachal Pradesh (HP). About 80 million people in *Hima Pradesh,* Indonesia were residing on designated forest lands in rural areas and were compelled to depend on the forest for their living e.g. extracting forest products and livestock grazing. Climate change led to degradation of the forest resource from adaptation to climate change and livelihoods. In turn, the country with vast natural resources base endured persistent rural poverty. No mention of models developed, tested and applied for the HP study, but still the findings and conclusions are worth noting as they highlight the most critical stages when developing study methodologies and approaches. Furthermore, remnant trees in pastures or agricultural fields provide habitat and resources that are otherwise absent from other landscapes. This is similar to a study by Harvey and Haber (1999) on a 237 Ha. of pastures in Montverde, Costa Rica in Latin America. The negative effects of climate change accelerated the disappearance of the natural forests thus unsustainable livelihoods leading to poverty for communities in the area. The methodology used for this study was interviews. Nevertheless, findings and conclusions in this study are useful and worth noting.

In Africa, the Upper Niger River Valley is located in Mali. According to AFR/SD; Environment Journal quoted in AWF (2003), over 30,000 households who were suffering from the impact of climate change in the area adopted practices that increase productivity and reduce degradation in the Upper Niger River Valley. While people improved their livelihoods through increased yields and diversification of revenue, they also reclaimed land and reduced forest degradation. Common to both cases were policies that devolved authority and increased user right security (the

right to use lands and the fruits of the land, without actual ownership: a right which when protected leads to better land stewardship), training that produced democratically selected, business-based CBOs, and strong links between investments in better natural resources management and revenue generation. In the Upper River Valley Zone (OHVN) of Mali, natural resource management was combined with intensified agriculture where farmers reclaimed eroded fields by treating them with contour rock lines including mineral and organic fertilizers to increase productivity and protect the environment. This went with no success due to climate change.

According to Longwe, in AWF (2003), Zambia is a landlocked country in Africa. The country has a total area of about 760,000km^2 and about 64,000km^2 or 8% of the country's land is devoted to 19 National Parks and about 162,000 km^2 or 24% of land is under 34 Game Management Areas. Chieftains Christine in AWF (2003) quoted also Eva Mambo Chiawa of the Zambezi Heartland saying '…wildlife is the key to our prosperity. Today we are making the elephant work for us, not against us. We are developing a cultural village for tourists to visit and a lodge for them to stay in. We are developing resources that elephants can't damage like beekeeping and fish farms. For the first time, we are cooperating with people in neighbouring parks and even other neighbouring countries. The African Wildlife Foundation calls this kind of work 'trans boundary' People call it hope. People have the right to grow and prosper. To deny them the use of their natural resources, to bar them from the landscapes that continue to shape their livelihoods is not only wrong, but it is impossible…' Nevertheless, according to Kaweche et al, in AWF (2003) a community based natural resource management programme – Administrative

Management Design for Game Management Areas (ADMADE) was introduced in Zambia in 1988. At first, there were 9 areas that were selected for ADMADE operations but later the philosophy was extended to most of the Zambia's 34 Game Management Areas. The principal objectives of the ADMADE programme were to involve the local communities in the management and conservation of wildlife, to ensure that part of the derived revenue is returned to the local communities to fund projects of their choice and to create employment opportunities.

It was discovered that more than US$ 2.6m have since been disbursed to the local communities. Out of this revenue, about 100 community projects have so far been funded and completed. The training and recruitment of about 750 village scouts is one way in which these communities have benefited in terms of employment opportunities. Adequate revenue is generated through sustainable utilization of wildlife and part of the revenue is returned to the areas to cover conservation costs. This shows clearly the efforts of linking game benefits to the community in Zambia.

According to Wells et al (1992) and Stoles et al (1997) all in AWF (2003), conservation efforts may be most effective when utilizing particular organisms and ecosystems with economic value in a sustainable manner. Lovemore Tinarwo quoted in AWF (2003) reports that the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) was introduced in Zimbabwe in 1986 as a strategy for empowering communities to manage their own natural resources in communal areas and curb some of the environmental problems including the impact of climate change. Before, in 1978, the Department of National Parks and Wildlife

Management (DNPWLM) introduced Wildlife Industry's New Development For All (WINDFALL) in an effort to improve attitude towards wildlife conservation in communal lands. Revenue derived from utilization of wildlife in areas surrounding National Parks were paid to respective Rural District Council (RDC). In 1982, the Parks and Wildlife Act was amended to allow RDCs to manage wildlife resources in their areas and accrue the benefits derived from such management processes. Generally, CAMPFIRE is concerned with wildlife, forestry, grazing and water resources. Wildlife has been the focus because of its potential to provide a high, direct and immediate financial return to those areas where wildlife resources are abundant. Generally, communities benefit livelihood support from CAMPFIRE.

A total of 36 RDCs, for example, have enabled communities to spearhead community development initiatives earning about Z$46m. during the period 1989 to 1995. CAMPFIRE is now generating Z$14m. annually. About 90% of this revenue is earned from consumptive tours. However, in efforts to consolidate income, some districts have started diversifying CAMPFIRE activities into photographic tours and eco-tourism. Communities have been able to identify, plan, manage and monitor their projects with very minimal interventions from outside. Communities have started maintaining infrastructure like fences, dams, boreholes and grinding mills. Some have set aside revenue for infrastructure maintenance. They invest in development of sustainable hunting quotas. Having realized the value of wildlife, communities set aside wilderness areas for wildlife and have developed fire management plans to protect the areas. CAMPFIRE committees have been instrumental in raising natural resource management awareness among communities.

The people i.e. the CAMPFIRE communities are now able to define beneficiary households for the purposes of household dividend allocations and distributions. Communities have been able to define their village boundaries and membership among many other things. Table 2.1 presents income generated through the CAMPFIRE programme for the period 1989 – 95.

Table 2. 1: Income through CAMPFIRE 1989 – 1995

Year	**Revenue (Z$)**	**% annual change**
1989	743,699	-
1990	1,564,825	110
1991	2,910,855	86
1992	6,063,989	108
1993	9,688,208	60
1994	13,489,562	39
1995	14,082,032	4
TOTAL	**48,543,170**	

Source: WWF Support to CAMPFIRE Note 1US$ = Z$11.3

Communities in CAMPFIRE districts have invested revenue from wildlife in progressive investments such as: a). Construction of school buildings and teachers' houses, b). purchase of furniture and books for schools, c). construction of clinics and nurses' houses, d). construction of community halls, e). construction of retail shops and stocking them with goods, f). construction of roads, g). provision of water for domestic use, livestock and wildlife, h). purchase and maintenance of grinding mills, i). purchase of tractors, dam scoopers and ploughs, j). putting up electric fences, k). funding maintenance of fences, boreholes and diesel engines, l). meet

fence and pump minders salaries, m). funding ward based training and n). funding village or ward administrative costs.

Communities are also investing into income generating projects like grinding mills, retail shops, cattle fattening schemes and management of eco-tourism camps. Investments into social infrastructure by communities has allowed local authorities to channel scarce financial resources to other areas that are not participating in CAMPFIRE i.e. non-CAMPFIRE wards and villages have also benefited from the investment in CAMPFIRE wards/villages. Today, because of the CAMPFIRE, rural communities in Zimbabwe appreciate the wildlife resource as an asset rather than a liability in their daily living.

Moreover, according to Ochere quoted in AWF (2003), the Transmara district covers an area of 3224 km^2 inclusive Maasai Mara west of Mara River towards the Maasai Mara National Game Reserve in Kenya. The abundance of fauna and flora makes the seasonal luminous evergreen Transmara district an area of concern for the conservation of the forest and game resources. However, these resources are affected by the influence exerted by the increasing population from outside into the district for both the resources, petty business, as well as, crop farming. The increasing population from outside has a notable influence on the forest resource in the area. Composition of the forest resource in Transmara district is: i). The afro-montane dry conifer forests; ii). The semi deciduous (semi evergreen forests); iii). The dry deciduous forests and iv). The woodland – savanna woodland. All these forests are classified into Hill-top, Riverine and Plateau / Plains / River basin forests.

The direct benefits from the forest resource in Transmara district is in a form of forest products such as firewood, charcoal, construction materials e.g. building poles and timber, carving woods, hives, stick or club as weapons, ropes, pots and mats including wood hoes. Other non-timber products include honey, grass and plants with medicinal functions. The indirect benefits that people in the area enjoy include services of water catchment, fresh air, as well as, the forest as home for local ritual functions. The forest generates also income from tourism and provide room for research apart from being habitat for wildlife. It offers also conducive environment for perennial and annual crop farming and grazing in areas surrounding forests.

Furthermore, the Samburu Heartland in Northern Kenya has some of the largest intact landscapes left in Africa including huge forests. Fiesta Warinwa of the Samburu Heartland was quoted in AWF (2003), saying that the Kenyan government assist Samburu communities improve the quality of their bee hives, form strong community associations and develop market outlets for honey and beeswax products. The local community's standard of living is going up where encroachment on the forest is going down. These forests are home to an amazing biodiversity, a shelter to countless plant and animal species. In the past, poor beekeeping has actually led to devastating forest fires. However, all of that is now changing. The local communities in Samburu have focused on apiculture as a key conservation enterprise because it rewards people for keeping their forest blocks intact. People in Samburu Heartland are now motivated to conserve forests. A Samburu native once said 'We'll never have enough rangers, scouts and wardens to keep loggers out of this forest. But we do have plenty of bees in the Samburu Heartland'.

Forests in Samburu land were disappearing fast. But now, what the loggers miss is what the villagers take for charcoal. Also as forests vanish, so does the wildlife. Beekeeping is an ancient practice in Samburu. Bee hives grow wild and are famous for being pure, healthy and pesticide-free. The Samburu project help people improve bee-keeping techniques, increase harvest and market the honey products. Now people have more economic incentive to conserve forests than to destroy them. Forests keep Samburu people safe from climate change and at the same time provide them with health options for adaptation during bad conditions.

Forming part of the Eastern Arc Mountains in Tanzania, the North Nguu Mountains is a succession of natural forest-top mountains that is a home to more than 1,500 plant species and 50 endemic species, rich of original forests under the influence of the Indian Ocean climatic regime (Lovett, 1985). The mountain ranges have been identified in all global biological analyses as one of 24 globally important "hot spots" for forest biodiversity (Seddon *et al.*, 1995), b). The area was identified as a component of the Afromontane archipelago-like regional centre of endemism by White (1983), a Global 200 Ecoregion of WWF (Olson and Dinerstein, 1998), part of a biodiversity hotspot of Conservation International (Mittermeier et al., 1998) and an Endemic Bird Area of Bird Life International (ICBP, 1992). The area also face the most urgent threat in terms of potential species extinctions (Brooks et al., 2002; Ricketts et al., 2005). All these indicate the extreme biological importance of The North Nguu Mountains in global and local terms (Magin and Chape, 2004).

Tanzania confronts extreme poverty challenge particularly in rural areas where deforestation is further compounded by high needs for biomass based energy that

provide 90% of the population with basic household energy supplies (Agrawala, et al., 2003). Long term consequences begin to manifest themselves through conditions of desertification that further limit agricultural returns and result in additional land clearing to meet basic household food security needs.

A typical chain of reactive adaptation consequences demonstrates common coping practices in rural communities that compromise food security and further increase existing climate change vulnerabilities. For example, adverse environmental impacts that limit productivity in crop production are often accompanied by increasing farm sizes to expand yields. This is further demonstrated in the loss of available water and wood fuel supplies that is paired with impending environmental stresses due to climate change. For this therefore, limitations to agricultural productivity are not only an impact of climate change in Tanzania, but they are also reflecting present reality limiting sustainable livelihoods for the majority of the population.

The Tanzania Josh Sebastian Agriculture Institute of Canada Climate Change Task Team for example discusses a 'climate change and livelihood opportunities' conceptual framework processes developed during a study in Morogoro, Tanzania on farmer's ways of coping with current climate variability that were increasing their vulnerability to future poverty and climate change i.e. unsustainable livelihoods. Although the studies do not clarify explicitly the forest resource coverage of the livelihood safety-net to communities for future times, but it dwells exactly in the area of the study on hand with the methodologies and approaches used indicating effectiveness and accuracy in data collection and analysis. Table 2.2 presents livelihood opportunities in relation to climate change.

Table 2. 2: Climate change and livelihood opportunities

COPING STRATEGIES: (expanding cultivation; reducing fallow; switching crops; engaging in wage employment; charcoal, brick and timber production; migration)	
Short term consequences	Soil erosion, Deforestation
Medium term consequences	Reduced water retention, increased flooding after rains and reduced water flow between rains.
Long term effects	Eroded natural resource base (the forest) that may not provide the same safety-net for livelihoods in the future.

Source: Ernhart, *et al., (*2004)

Mount Kilimanjaro in Tanzania (5,895m.a.s.l) is located 2°25'and 4° 15' S; 36°25' 3" and 38°18' 00" E, covering 388,500 ha. in Tanzania. It is the highest mountain in Africa and the highest free standing mountain in the world. The Mountain ecosystems command an area of 13,209 km2 (approximately 1.4% of the total area in Tanzania). Specific values of the forest resource that covers Mt. Kilimanjaro include being a rich base for drainage, climate, soils and vegetation, which jointly provide water catchment for agriculture, hydropower and other water based livelihoods including tourism potential. However, according to NEMC (2006), the rapid increase in population and climate change effects contributed to the deterioration and depletion of the natural resources base of Mount Kilimanjaro ecosystem.

Similar to the proposed study, the study conducted by NEMC in 2006 focused on the impacts of climate change with regard to the Mountain Forest resource (ecological biodiversity and local livelihood systems similar to the proposed study). The

methodology or approach of clustering settlements before studying local livelihoods in the area was good and adopting such an approach will be useful in generating accurate and more focused information in the proposed study. Nevertheless, budgetary constraints limited use of aerial surveys.

According to Anon (1981), the Ngorongoro ecosystem in Tanzania maintains a historic balance of people and nature in vital water catchment areas where man, livestock and wildlife co-exist without harm or destroying each other's habitats. The surrounding area of the Ngorongoro Crater is an area that embraces several distinct habitats from open grasslands to mountain forest and from scrub bush land to highland heath containing sites of international paleontological and archaeological importance with around 25,000 animals (a number that can swell to 2.5 million depending on the season). The mixture of forest, canyons, grassland plain, lakes and marshes provide habitats for a wide range of bird life as well. However, due to the negative impacts of climate change, the forest resource outside the Ngorongoro Conservation area started to deteriorate faster. As the forest deteriorated outside the conservation area, so did the game and the birds. Livelihood outside the Ngorongoro Conservation Area started to become difficult. Communities in the area were becoming more risk prone to poverty. The methodology or approach of collecting data from individuals, families and households was good. Findings and conclusions from this study are very useful when analyzing data for this study.

According to Siege L. at al, in AWF (2003), the Selous Game Reserve in Tanzania occupies an area of around 45,000 km^2 (about 5% of Tanzania's land surface). With

its extensive area of *miombo* woodlands, the SGR encompass a wide range of open grasslands with a variety of *acacia* tree species. The Selous is one of the largest forest areas under protection in Tanzania. Due to its unique ecological productivity and the hunting quota system, livelihoods certainly with the options for adaptation in the SGR have increasingly going on sustainably. However, due to some negative effects of climate change, the forest habitat for wildlife came under pressure and was deteriorating faster. Harvests from the hunting quota system started to go down. In turn, communities in the area started to experience unsustainable livelihood, low income and clearly consistently being pushed to poverty. Though no mention of paradigms models and theories developed that could be referred to, but findings and conclusions from this study are worth noting when conducting this study.

The South Nguru Mountains form part of the Eastern Arc Mountain Chain stretching from southern Kenya to southern Tanzania. A study on 'Climate Change and Nature' by IUCN (2002) indicated that communities living in and around the South Nguru Mountains depend almost entirely on the natural resource based (the forest) in the area. The Tanzania Forest Conservation Group (TFCG) and CARE undertook a participatory research to understand what (if any) climatic changes were being experienced and how local living conditions were being affected in the area. The results were striking. Communities were unanimous in pronouncing trends such as rising temperatures, an on-set of rainy and dry seasons became much less predictable and increased frequency, intensity and duration of droughts and floods. The methodology was good. Though no mention of paradigms models and theories developed, still the findings in this study are worth noting.

According to IUCN (2004), Shinyanga region in Tanzania was in the early 1920s extensively forested. By 1970s the area was under severe ecological strain, with severe land degradation that was impacted by climate change. This led to food insecurity and poverty to the surrounding local communities. The review of climate trends and scenarios based upon an examination of livelihood strategies and results, as well as, empirical observations and results were conducted and published as part of national communications, country studies and scientific literature. Similar to the proposed study, the IUCN sponsored study was focused at climate change, the forest resource and local livelihood systems. Methodologies or approaches used for studying local livelihoods (from individual family members and sometimes members of a household) in the area were much more effective. The findings and conclusions from this study were worth noting and had strong contributions for developing methodologies and approaches for this study.

Created in 1995 and covering an area of 5,000 hectares, the Jozani Chwaka Bay Conservation area was declared a national park in 2005 aimed at fostering the survival of the area and its surrounding habitats that host natural ecosystems with various flora and fauna species including indigenous endemic and endangered species. The Chwaka Bay mangroves cover an area of 2,394 ha. The park mangrove covers an area of 1,828 ha. There are three zones in the mangrove park. One is strictly for protection while the other two are alternative working circle and harvesting units for sustaining livelihoods during normal situations and as an option for adaptation when changing weather takes long (NEMC, 2006). Similarly, the Menai Bay Conservation Area (MBCA) is situated in the southwest coast of Unguja

Island in Zanzibar and has an area of 470 km^2 with population of 27,502 people (2002). MBCA was set up in 1988 and officially gazetted as a conservation area in 1997.The main goal of MBCA is to conserve the biological diversity, ecological processes and productivity of the area and associated ecosystems to ensure that resources are sufficient for local people to sustain livelihoods and opt them for adaptation when need be (NEMC, 2006).

According to Titu in Lushoto District Council (1998), Lushoto District cover an area of 3500 km^2 in Tanzania. Protected areas for closed Forest Reserves under the Central Government in Lushoto district is 34,000 Ha. Closed Forest Reserves under the Local Government Authority in Lushoto district is 1,700 Ha. Forest plantations (central government) in Lushoto district is 3,400 Ha. Population increase coupled with an increase in economic activities mainly adaptations to climate change in the district resulted in competition in the utilization of forest products hence scarcity and deterioration of the forest resource. Moreover, food insecurity and desertification threatened livelihoods in the area and in 1981 the Soil Erosion Control and Agroforestry Project – SECAP was introduced in the area to contain the situation.

The initiatives in Lushoto were adopted and managed by local communities and has been a great input to improving local livelihoods and support to local economic growth in the area. The findings and conclusions from this study are very useful to consider when analyzing the impact of climate change on livelihoods.

Table 2.3 presents SECAP progress in Lushoto district for the period 1981 – 1998.

Table 2. 3: Progress of The Soil Erosion Control and Agroforestry Project – SECAP 1981– 98

PROGRESS	PERIOD					TOTAL
	1981-84	1984-88	1988-92	1992-97	1997-00	
1. Farmers apply SWC measures	157	750	650	2346	2421	6324
2. Grass macro contour lines	314 km	1500km	1300km	2050km	0	5164km
3. Cut off drains (COD)	0	0	0	64879m	0	64879m
4. Fanya Juu terraces (FJT)	0	0	0	326762m	0	326762m
5. Bench terraces (BT)	0	0	0	633484m	0	633484m
6. Grassplots	1350m^3	5400m^3	4840m^3	4089m^3	540m^3	16219m^3
7. Trained Village Extension	11	50	42	39	47	189
8. Trained Village Technicians	0	0	34	147	12	193
9. Trained farmers – SWC	1438	3300	3270	1970	2913	12891
10. Train animal husbandry	12	500	1053	1565	2913	6043
11. Train tree planting	-	487	175	773	70	1505
12. Train horticulture marketing	0	0	360	562	142	1064
13. Forest trees central nurseries	12800	230000	2591000	1517219	0	4351019
14. Forest trees contact nurseries	0	0	0	517001	60000	577001
15. Forest trees private nurseries	0	3150000	3110000	1134431	482878	7877301
16. Area with SWC COD BT FJT	169Ha.	253Ha.	211Ha.	843Ha.	470Ha.	1946Ha.
17. Afforestation – hill tops	16 Ha.	288Ha.	3239Ha.	2543Ha.	60Ha.	6146Ha.
18. Area under agroforestry	0	31500Ha	31100Ha	11344Ha	5079Ha.	79023Ha.
19. Stalls for bulls and heifers	44	125	43	5	0	217
20. Heifer offered	44	125	25	0	0	194
21. Bulls offered	4	35	27	38	0	104
22. Sold oxen	0	31	3	0	0	34
23. Oxcarts sold	0	31	2	0	0	33
24. Improved seedlings (hort.)	0	50000	39000	43276	27925	160201
25. Sold improved seedlings	0	0	0	37750	19113	56863
26. Sold horticultural products	0	0	0	5tons	159tons	164tons
27. Train women groups	0	0	139	78	0	217
28. Train counterparts	4	10	44	46	5	109
29. Conserved catchments	0	0	0	35Ha.	26Ha.	61ha.

Source: Lushoto District Council (1998).

The Great Ruaha River forms the Rufiji River, 177,000 km2. The Great Ruaha catchment area covers 83,970 km2 or 47% of the Rufiji basin. The population of Dodoma, Singida, Iringa, and Mbeya in Tanzania (an area under the Great Ruaha River ecosystem command) was estimated at 6.3 million with a growth rate of 2.8% per year (2000). Agriculture contributes 90% of the livelihoods. The area produces 35,000ha of irrigated paddy worth 19.5 billion shillings; 65,000ha area of rain fed cultivated maize producing maize worth 8.8 billion shillings; 300,000 head of livestock; and 700 tons of fish per year (NEMC, 2006). The biodiversity of the area under the command of the great Ruaha river includes miombo and acacia woodlands, several thousands of elephants, hippopotamus, giraffe, buffalo, kudu, and Roan and Sable antelopes, wild dogs, and lions in the Ruaha National Park. Usangu plains are an important bird area with 450 species including large aggregations of migratory wetland birds. The montane woodlands of the Kipengere and Livingstone mountains contain several endemic, altitudinal plants and animals of various species.

According to NEMC (2006), Lake Tanganyika lies between latitudes 3’20’ and 8’48’ south, and longitudes 29’05’ and 31’15 east. The riparian countries are Burundi, Democratic Republic of Congo, Tanzania and Zambia. The surface altitude of the lake is 773 metres. It is the second oldest lake in the world. The mean width of the lake is 50 kilometres, mean length is 650 kilometers, mean depth is 570 metres, and the surface area is 33,000 km2 while the drainage area is 231,000km2. The population in the drainage area is 10 million, there are over 2,000 aquatic organisms and at least 600 endemic species. The threats to the lake are mainly man-induced and include: excessive sedimentation; pollution; over fishing and habitat destruction. The

impact of climate change in the area results into: sedimentation increase due to inappropriate land use activities; habitat destruction; eutrophication; reduced light penetration; reduction in water quality; reduction in biodiversity and decline in lake productivity. However, as a result of improved fish harvesting management, fish harvesting is between 165,000 and 200,000 metric tons. This supports sustainable livelihoods and reducing poverty for communities in the Lake Tanganyika basin.

Manyara ranch is 45,000acre fascinating microcosm of a livestock enterprise that occupies a vital wildlife corridor between Lake Manyara and Tarangire National Parks in Tanzania. By working on improving the ranch, the AWF is able to track and study wildlife movement between the two parks. This is to ensure the continued migration of wildlife and provide jobs and income to the local community. The AWF has constructed living quarters for staff and their families. Through the ranch, the local community in the area rehabilitated a school moving it out of the wildlife corridor and giving it some long overdue facility upgrades. Existing breeds of cattle and sheep are being improved and the local communities are assisted to develop a market for beef in the area. Generally, communities in the area consider Manyara Ranch to be more than a wildlife crossroads. It is for them an intersection where people, animals and landscapes meet, live and prosper together.

The Lake Manyara and Tarangire National Parks in Tanzania scenario is more of a model for the future of conservation everywhere. It is a glimpse of the future of Africa. A prominent local community member said once that ‘I worked at Manyara ranch for the money. Then I began to do it for the wildlife. Now, more than anything

else, I do it to help my people ... I grew up believing that my fellow Maasai people living around Manyara had two choices: agriculture or cattle ranching. Then I became a game scout at Manyara ranch, protecting wildlife and a vital corridor between two national parks. Sure, I track wildlife. But I also work constantly with the people, sharing ideas with them to tread lightly on the landscape. For there can be no wildlife without habitat and there can be no habitat without the people. It hasn't been easy, but slowly, the light is coming on. They're discovering that they have more choices; that they can be more prosperous with wildlife than without. Wildlife just got in our way but now it points the way to our future...' (AWF, 2003).

According to Twong'o and Sikoyo in AWF (2003), the Minziro-Sango Bay swamp Forest reserves lay astride the Tanzania - Uganda border at the western shores of Lake Victoria. The Minziro reserves (249km2) in Bukoba Tanzania are contiguous to the Sango Bay forests located in Rakai, Uganda. Five major forests (Kaiso, Malabigambo, Namalala, Tero West and Tero East) together with two smaller blocks of Kabira and Kigoma, comprise the Sango Bay reserves. The five major blocks cover a total area of 151 km2, with a perimeter of 187 km, of which 156 km adjoin local communities. Of the 187-km boundary of Sango Bay forests, 176 km was un demarcated swamp edge while 11 km was artificial boundary (3km along Kaiso and 8 km along Malabigambo) with the Minziro Forest Reserve. Resources of Minziro-Sango Bay swamp forests and their status Minziro-Sango Bay Forest reserves are the most extensive swamp forest in East Africa. Large, seasonally flooded grassland swamps, in turn, surround them and together, they comprise an important ecological component in the Kagera flood plain ecosystem, which regulated the flow of water

through the river. The reserves were best known for the extensive nature of their swamp forests, the high density of the popular tree Podo (*Podocarpus usambarensis*), the large number of butterfly species (600 in Minziro alone), and for the Important Bird Area (IBA) on Musambwa Island just off the mainland in Lake Victoria. Swamp fisheries (exploited as wetlands recede) and the extensive grassland swamps (used especially for dry season grazing), were very important resources for livelihoods and or options for adaptation to the local and neighbouring communities.

According to Burges *et al.,* (2000), stretching out east of Kilindi district in Tanzania, the North Nguu Mountains (the study area) is among the thirteen separate mountain blocks found in 14 Districts within 5 regions of Tanzania that comprise the Eastern Arc Mountains ranges. North Nguu Mountains contains 11 Catchment Forest Reserves that include Kilindi, Kwediboma, Mkuli (West of River Mkuli), Mkongo, Mbwegere, Derema, Pumula, Rudewa South, Jungu and Nguru North (14042 ha. 1550 meters a.s.l.) all totaling around 30,337 ha. Forests of North Nguu Mountains are of sub-montane grading (IUCN 2003). Generally, North Nguu Mountains are of economic, social and environmental importance as sources of timber and non-timber products including building poles, fuel wood, household utensils, traditional medicines, honey, thatching materials, fruits and vegetables including animal protein [Burgess *et al.*, (2000); KDC, (2000)].

2.3.3 Policy review on climate change, livelihoods and the forest

Tanzania signed the United Nations Convention to Combat Desertification and Mitigate Drought Effects (UNCCD) in 1994 and ratified it in 1997. The country took

part also in Conferences of the Parties (CoP) such as the 2003 United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD). Others include the World Climate Conferences in Geneva (1979, 1990, and 2009), The United Nations Conference on Environment and Development (UNCED) a process that led to the 1992 Earth Summit on climate change and The World Summit on Sustainable Development in Johannesburg (2002).

Nevertheless, establishment of The Inter-governmental Panel on Climate Change (IPCC) and the Inter-governmental Negotiating Committee for the United Nations Framework Convention on Climate Change are important milestones for the country's drivenness on addressing climate change and livelihoods at global level. In line with its commitment to the UNCCD, Tanzania developed The National Forestry Programme and Legislation for implementation of The Tanzania National Forestry Policy (1998). The policy introduced new forms of partnerships for forest management and profit sharing through the Joint Forest Management–JFM (2000) and Community Based Forest Management–CBFM (2000).

In 2001 The National Biological Diversity Strategy and Action Plan - NBSAP was developed to address strategies and action plans for conservation of among others, agro-biodiversity and terrestrial biodiversity. In 2004 the country introduced The National Action Programme to Combating Desertification – NAP. This programme was initiated as an enabling environment for addressing among other issues, biodiversity conservation and vegetation cover within the policy frameworks of the existing land use and land tenure systems.

The second national report for the implementation of the Convention on Biological Diversity (2004) showed that most of the NBSAP terrestrial and agro-biodiversity programmes were complementary to those in the NAP. NAP was then formally integrated in The National Environment Policy – NEP (1997), The National Forestry Policy (1998) and The National Environment Management Act No. 20 of 2004. A report on National Action Plan on Climate Change was prepared and a National Adaptation Programme of Action – NAPA (2007) was prepared. However, According to Agrawala, et al., (2003), despite the declining water recharge and water catchment in the country, Tanzania's National Water Policy – NAWAPO (2002) is hardly making any reference to the changing weather conditions or rather climate change in the country.

2.4 Research Gap

There are explicit converging arguments from reviewed literature that climate change kicks up tremendous impacts on livelihoods. Literature, for example, recognize the forest to be vulnerable to climate change (Agrawala, *et al.,*); but also a readily available capital for adaptation and rural livelihoods (UNEP, 1995). Reviewed literature indicates the forest to be integral to conserving biological diversity and ecosystems with provision of sustainable options for adaptation and livelihoods. Literature exemplify further on significance of the forest resource together with policy support on forest management as paramount for sustainable livelihoods. However, there is basically no information on the major root causes for unsustainable livelihoods and poor options for adaptation despite the forest potential for communities in the North Nguu Mountains.

2.5 Summary

Generally, the world's poor depend critically on healthy ecosystems for their livelihoods where biodiversity provides significant economic, aesthetic, health, and cultural benefits that form the foundation for sustainable livelihood and local economic development (UNEP, 1995). Two constituents that have been identified as essential for improving well-being and reducing poverty through biodiversity and ecosystem management are: a). being able to continue using natural elements found in ecosystems for traditional cultural and spiritual practices; and b). being able to make decisions that are sustainable, respect natural resources management and that can enable achievement of a sustainable income (UNEP 2001).

Natural ecosystem services are in decline as land is being degraded mainly because of population growth (World Bank, 2007). Earnings from wildlife, forest and mountain ecosystem accounted for 6% of GDP in Tanzania and when the direct and indirect benefits combined, the sector's contribution to GDP was 12.4% for 1999 (NEMC, 2006). A sound management of ecosystems is therefore of paramount importance for economic growth and improvement of livelihoods. According to the World Resources Institute (1992), monitorable outputs of forest ecosystems management related activities include: a). Protected areas i.e. systems of forest conservation units with effective management plans; b). Threat removal i.e. removal of the causes of biodiversity loss and the specific threats to the ecosystem, for example, through reduced encroachment; c). Sectoral integration i.e. incorporation of biodiversity protection into the main productive sectors of the economy i.e. integrated community development; c). Sustainable logging and other forest

industries; and d). Institutional strengthening i.e. stronger institutions and trained staff to address forest ecosystem management issues. According to reviewed literature, management of natural ecosystems particularly the forest is of paramount importance for economic growth and improvement of the livelihoods of the people. Despite the natural resources endowment and favourable policy support frameworks, there is still a knowledge gap in the root causes of the impact of climate change on rural livelihoods in Tanzania.

CHAPTER THREE
3.0 RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the methodology used to conduct this study. It outlines approaches used for data collection, data analysis and data presentation. Information from this chapter is presented in four sections where section one presents information on the study area. It presents the location and topography of the study area; the climate (rainfall, temperature, vegetation); soil types, as well as, the people and livelihoods in the area. Section two presents the design of the study. Section three presents the methods used to conduct this study.

The study used analytical survey methods to analyze the situation on how rural communities adapt to or grasp with the impact of climate change as presented in the statement of the problem for this study. Through analytical surveys, appropriate statistical tools were used to probe certain hidden meanings (Leedy, 1980). However, since information is developed by the people themselves through their interactions with other actors, the researcher stayed with communities watching, listening and asking questions so as to grasp their perceptions and visions (Hammersley and Atkinson, 1995). The encounter between the study and the study population provided new dynamics and new insights; it enriched data interpretation for developing knowledge for action (Leedy, 1980). Information on the methods used to conduct this study is presented in three subsections: subsection one presents the study sample and sample size; subsection two presents data collection tools and techniques highlighting on validity and reliability of the primary and secondary data

including that from documentary review. Section three presents data analysis and section four picture out some ethical issues during this study. Section five gives some details on how information generated from this study is presented.

3.2 The Study Area

3.2.1 Location and topography

Before declared a district, Kilindi was part of an area that was surveyed, defined, officially gazetted and declared Handeni district covering 13,209 km^2 in 1954 under article 7 of the Tanganyika Order in Council of 1920. Kilindi area (south west of Handeni district) was later in 2002 re-surveyed and declared a district covering 6,129km^2. The district is located within latitudes 5^0 18' and 5^0 48' south of the equator and longitude 37^0 and 38^0 45' east of the Greenwich prime meridian in northeast Tanzania.

Forming part of the Eastern Arc Mountain ranges, a chain of ancient crystalline mountains near the Indian Ocean that stretches out across east of Kenya and Tanzania, The North Nguu Mountains in Kilindi district lies within an altitude ranging from 500 to 1800m where most of the area is covered by hills and mountains (Burges *et al.*, 2000). Nevertheless, the Mountain-top forests in The North Nguu Mountains are of an extreme biological importance in local and global terms.

Figure 3.1 Presents sketch map of the North Nguu Mountains and Table 3.1 presents the mountain-top forest base of The North Nguu Mountains.

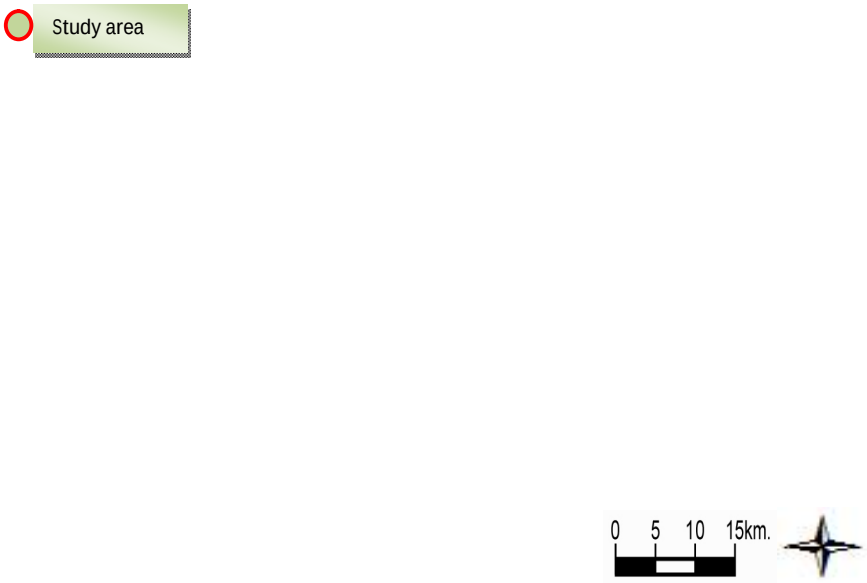

Figure 3. 1: Sketch position of the North Nguu Mountains

Source: Eastern Arc Mountains – Kingdon & Howell, 1993

Table 3. 1: The mountain top-forest base of The North Nguu Mountains

Mountain	**Altitude (m) a.s.l.**	**Location**	**Top Forest Cover (Ha)**
Bondo	1,011	5^0 47’ S, 37^0 28’ E	328
Jungu	1,230	4^0 27’ - 4^0 38’ S, 37^0 36’ - 37^0 32’ E	369
Kilindi	1,520	5^0 33’ - 5^0 40’ S, 37^0 33’ - 37^0 36’ E	4,299
Kwediboma	1,300	5^0 26’S, 37^0 33’ E	285
Mbwegere	1,160	5^0 45’ S, 37^0 29’ E	368
Mkongo	1,130	5^0 27’ - 5^0 29’ S, 37^0 33’ E	985
Mkuli	1,260	5^0 47’ S, 37^0 28’ E	2,931
Nderema	1,620	5^0 42’ - 5^0 37’ - 5^0 37’ S, 37^0 32’- 37^0 27’ E	3,928
North Nguu	1,550	5^0 27’ - 5^0 38’ S, 37^0 36’ - 37^0 32’ E	14,042
Pumula	1,160	5^0 40’ - 5^0 44’ S, 37^0 32’ - 37^0 28’ E	1,062

Source: Forest department - Kilindi District, Tanzania (2012)

The North Nguu Mountains consist of about eleven (11) separate sub-montane grading forest-top free standing mountains. Figure 3.2 presents Kilindi district and the study area i.e. The North Nguu Mountains whereas Table 3.2 presents location and area coverage of the forest in each study village.

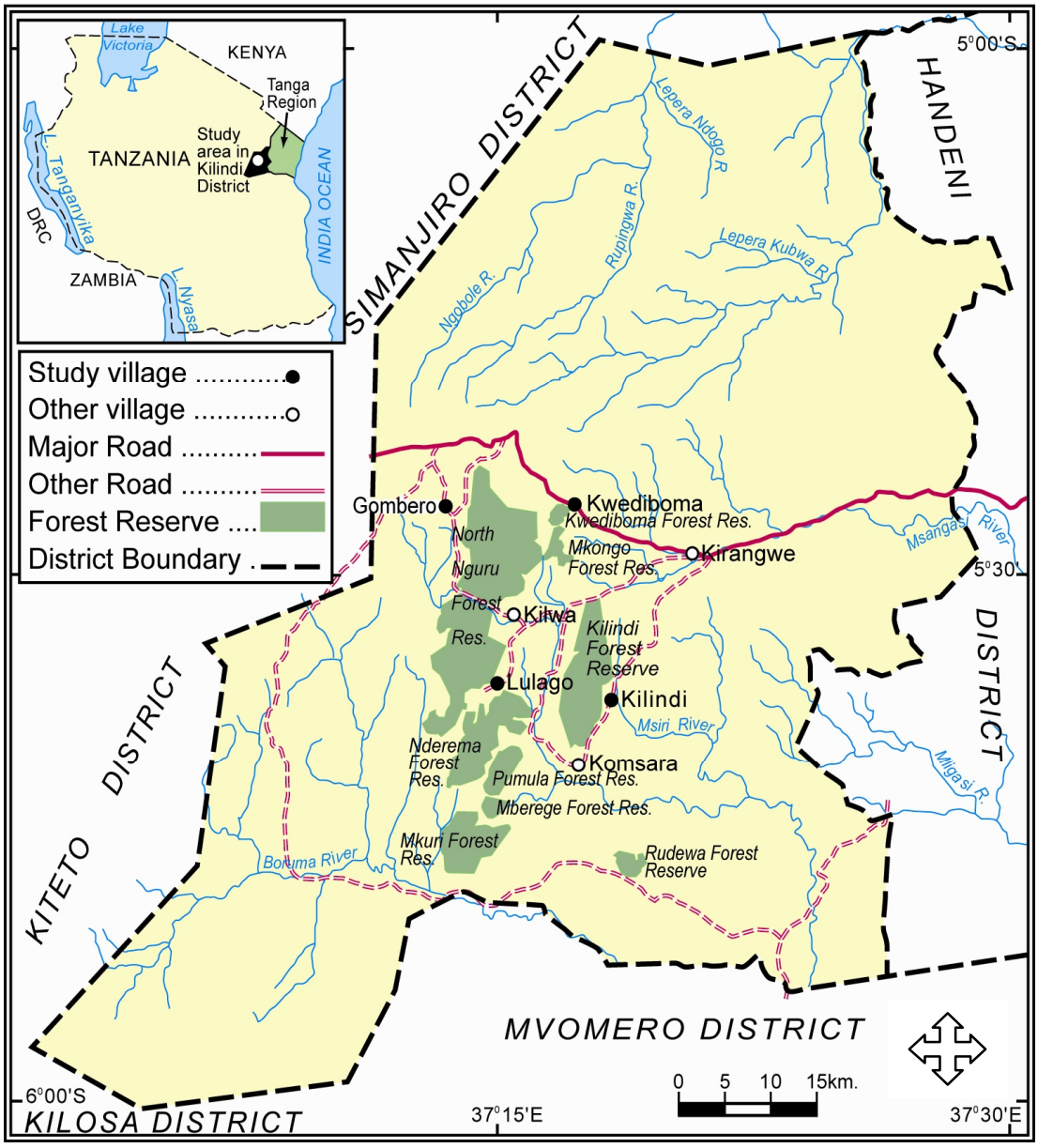

Figure 3. 2: The study area

Source: Cartographic Unit (2011): University of Dar es Salaam

Table 3. 2: Location and coverage of the study area

Village	**The Forest coverage (Ha)**		**Location of the forest**
Gombero	North Nguu FR	13,911.7	5^0 27' – 5^0 38' S 37^0 36' – 37^0 32' E
Lulago			
Kilindi	Kilindi FR	4,299	5^0 33' – 5^0 40' S 37^0 33' – 37^0 36' E
Kwediboma	Kwediboma FR	284.9	5^0 33' – 5^0 40' S 37^0 33' – 37^0 36' E

Source: Kilindi District Forest Office - Kilindi District, Tanzania (2012)

3.2.2 Population, settlements and livelihoods

a). Population

The population of Kilindi district is 236,833 people (118,065M, 118,768F) with household size of 5.1 and sex ratio of 99 (URT, 2012). However, this study was done shortly before the 2012 National Population Census and the population of the study villages as provided by the respective village governments were Kilindi village 2,498 (1,264F, 1,234M); Kwediboma village 4,445 (2,236F, 2,209M); Lulago village 2,118 (1,067F, 1,051M) and Gombero village 2,895 (1,464F, 1,431M).

b). Settlements

Discussions with the community (particularly the elders) in the study villages revealed further that contrary to how the villages look now, most of the settlements in the area were not existing as villages but as traditional kinship family settlements (one to three families) of the same kinship. Moreover, enumeration of individuals in the traditional settlements was difficult by that time. It was difficult for people, for example, to disclose the number of people particularly widows and un-married

young girls due to some cultural and ethical issues embodied in the norms and values of the communities in the area by that time. There was also fear from the government enforcing poll tax from community members. This made some people in the area not to comply with the first (1968) after independence census i.e. enumeration processes in the area was very difficult. The issue became increasingly complex during the following enumeration (census) processes in 1972 when the whole country was under the villagization process where some settlements were dislocated, some split out and others merged into other settlements resulting to extreme social interactions.

c). The people and livelihoods

The dominant ethnic groups in the North Nguu Mountains are *Wanguu* and *Wamasai*. *Wanguu* are predominantly crop farmers whereas *Wamasai* are considered immigrants from the nomadic semi-sedentary cattle keepers. *Wamasai* are living in scattered temporary homesteads mainly under agro-pastoral systems. According to Agrawal (2003), local communities in the North Nguu Mountains are characterized by a diversity in livelihood strategies and options for adaptations. The environment in which they live, crops, species and breeds of livestock they rise, their cultural practices, their specific norms and values, as well as, the way in which they respond to outside pressure varies from the other community members in the area.

d). The economy

The main crops grown in the area include maize, beans, cassava, sweet potatoes, paddy, cardamom, sunflowers, cow peas and rice including a variety of vegetables. The main livestock herds in the area include cattle, goats, sheep and donkeys. Poultry

and keeping small ruminants is common in the area. Some individuals, families or households earn part of their living from collection of specific bits and pieces from game and non-timber forest products. A few more make part of their living from hunting and others from petty trading (HIAP, 2000; KDC, 2000).

Moreover, livestock in the North Nguu Mountains are heavily dependent on natural pastures. The key livestock management strategies in the area include herd mobility, herd diversification, herd splitting, as well as, maintaining several species of animals in one herd. The common characteristics of the pastoral communities in the North Nguu Mountains include: families depending significantly on livestock for food and income; crop farming taken as a subsidiary strategy to supplement subsistence needs, as well as, livestock herds composed of mainly indigenous breeds representing economic, social, cultural and spiritual assets while defining and providing social identity and security (HIAP, 2000; KDC, 2000).

Generally, livelihoods in the North Nguu Mountains are mostly under crop farming and pastoral grazing. North of the study villages is the Handeni Game Controlled Area. The area is of semi-arid savannah grassland with dry sub humid ecosystems. The natural scenarios of the forest combined with wildlife provide areas of local cultural importance with high biodiversity that constitutes critical watersheds and other life support systems to livelihoods and are of economic mainstay for the area. However, the changing vegetation in the North Nguu Mountains is mainly attributed to by forest fires caused by honey collection, clearing farms, charcoal burning, poachers, pit sawyers and lightning (KDC, 2000).

e). Rainfall and temperature

Kilindi district and particularly The North Nguu Mountains is one of the most important hydro geographical features in Tanzania. Its high catchment value influences the unique dynamics of the arid and semi-arid lands that surrounds the area. The abundant rich and natural mountain-top forests in the area is generally of economic, social and environmental importance as a source of high biodiversity that constitutes critical watersheds for life support systems in the area (IUCN, 2003). Rainfall is the primary source of water in The North Nguu Mountains. According to KDC (2000), rainfall in Kilindi area is bimodal with short rains starting in mid-October ending late January. The long rains start in mid-March ending early June.

According to Köppen and Geiger (2010), the average rainfall was 949mm for 1982 and 1,877mm for 2012. The annual average temperatures were 22^0C and 26^0C respectively the same period in the same area. Generally, the higher mountain areas are cooler at night where the lowlands become moderately warm during the day. With a large range in altitude about 1,620m above sea level, the mountain-top forest belt of The North Nguu Mountains is mostly important as habitat for bio-mass ecosystems and species diversity.

f). Water

The area has four permanent rivers namely Kiseru, Nkobe, Msiri and Songe with two seasonal rivers namely Kwedipela and Luhiga. There are also permanent streams such as Chajula and Chafa (HIAP, 2000). However, people depend solely on bore holes for domestic water and no supply services of clean water in all the study villages. However, the natural mountain - top forests makes the area to have reliable

high rainfall patterns with rich diversity of ecosystems providing water to humans, livestock and wildlife. Water availability has increasingly becoming under threat in The North Nguu Mountain (KDC, 2000). Degradation of the natural mountain top forests affects quality of water in rivers and watersheds while changing water levels and salinity that affects also underground water from bore holes (HIAP, 2000). Generally, problems of water availability in The North Nguu Mountains affects crop farming and the nomadic agro-pastoral systems in the area (KDC, 2000).

g). Soil types

Soils of Kilindi are basically with sandy loam texture mostly found in the low areas. The soil is blackish sandy loam humic latosol over gneissic basement rocks in some areas whereas the sandy loam soil is found in the northern part of Kilindi. Some light brown sandy loam with bare rock over gneissic basement rock together with seasonally water logged well drained light brown sandy loam over gneissic basement rocks together with the black sandy loam (humic latosol) on gneissic basement rocks are spread all over the lowlands and bottom valleys of the forest top mountains in the whole of The North Nguu Mountains area (Liebhardt, 1983). Loss of soil organic matter (SOM) and depletion of total soil nitrogen (TSN) are major factors responsible for declining productivity and quality of soils in the tropics, as it is also the case for soils of The North Nguu Mountains in Kilindi district, Tanzania (Liebhardt 1983; Chowdhury et al., 1983).

3.3 Research Design

This study is primarily analytical and partly descriptive with some elements attached to historical features such as testimonies on events that link significant long term

changing weather conditions with people's daily living i.e. livelihood strategies and systems in The North Nguu Mountains. Structure and design of this study emerges from climate change and livelihoods ideas converging from Burges, (2000), Groot *et al.,* (2002) and Heal *et al.,* (2004). Also, the comprehensive conceptual model for disaster management as applied by Kelly (1998) with some ideas on the involvement of communities in managing livelihoods, as well as, selecting and sustaining the options for adaptations from the power and participatory development model that illustrates a social process that embodies sharing of knowledge for action taking (Nelson *et al.,* 1995). The study used descriptive survey methods to generate and process discrete primary and secondary data (both quantitative and qualitative) on micro-level livelihood practices in adapting to climate change.

3.3.1 The study population

As provided by the respective village governments during this study, the population for this study was 11,956 people (6,031F, 5,925M) i.e. Kilindi village 2,498 (1,264F, 1,234M); Kwediboma village 4,445 (2,236F, 2,209M); Lulago village 2,118 (1,067F, 1,051M) and Gombero village 2,895 (1,464F, 1,431M) as presented in Section 3.2.2.1. The population consisted of local community members who were residing and making their living within the North Nguu Mountains. The population was made of individuals, families and groups that included youths, adults and elders both male and female regardless of their formal education levels.

Generally, the study population was a homogeneous group of individuals that consisted definite strata alongside livelihood strategies where each strata was distinctly different from the other but individuals within the stratum as homogeneous

as possible. Selection of the study population considered inclusion of definite community members in precise parameters for ensuring discreteness alongside livelihood strategies in the area.

3.3.2 The study sample and sample size

a). The study sample

Given the location, size and the homogeneity of the study population, village resident registers were used as a sampling frame to identify and select individuals that were to be involved in the study i.e. study sample. Each name in the village register was assigned a number. The numbers were written on separate pieces of paper and put into a closed container. The closed container was tossed so that the pieces of paper got mixed thoroughly. One villager was asked to select a bunch of pieces of paper without looking inside the container. The selected numbers were recorded. This process was repeated in all the study villages.

b). The sample size

The sample size for this study consisted of 1,195 people. However, based on knowledge and experience to specific requirements of the study, with assistance from the traditional local leaders, the study handpicked 55 other people from all the study villages and add them to the study sample. The sample size for this study was therefore made up of a total of 1,250 people (631F, 619M). The study organized the study sample into age groups i.e. youngsters (below 25 years), adults (26 – 50 years) and the elders (51 years and above). The selected study sample comprised of youths (25.8%), adults (38.8%) and elders (35.4%) whereas, the education level of the

groups ranged from those who never attended school (21.5%), those who attended literacy programs (21.3%), those who attended primary school i.e. the compulsory education level in the country (20.5%), secondary education (19.4%) and those who attended post-secondary education (17.3%).

Most of those who were reached were elders (42%), adults (37%) and youths (21%). A few elders never attended formal school but most of them attended various levels of informal traditional training programs. Most of the adults attended literacy programs while others together with the youths attended various levels of formal education with a few others attending higher learning programs at various levels within and outside the area.

3.3.3 Data collection tools and techniques

This study was carried out in three phases. Phase one was on adopting the research problem, pre-literature review and preparing the research proposal. Phase two was data collection and phase three was processing and analyzing the data, consultations and presenting the research findings. Data collection was done with support from four research assistants collecting information from individuals, families and households in the study area. Data collection methods and instruments were semi structured interviews, Focus Group Discussions, observation, as well as, use of secondary data mainly rainfall records. Moreover, documentary review was used as a source of secondary information for the study. The other approaches used for data collection include observing the visitors registers that were kept in the village government office in all the study villages recording visiting teams for various

purposes including recreation or learning events. Nevertheless, the prominent data collection techniques and the respective tools that were used for this study include:

a). Questionnaire interview

Primary data for this study were collected by use of a questionnaire. The questionnaire prompted respondents to share knowledge during data collection for this study. Data from questionnaire were used to verify information from the formal and informal discussions with leaders and other influential persons including information from the handpicked respondents (Appendix 1a).

b). Focus Group Discussions

The study collected also information through Focus Group Discussion sessions with various livelihood groups. According to Leedy (1980), focus group discussion emerges from conversational analysis i.e. conversation and talk amongst participants specified by gender, ethnic group or any other socio-economic class who make sense of the topic under discussion. Individuals and groups with similar backgrounds or experiences discussed issues on climate change, the forest and livelihoods guided by a moderator. There were a total of five (5) formal Focus Group Discussion – FGD sessions, one from each study village and one for the field technical staff (extension officers) at district level. Communities that were involved in the discussions include crop farmers, livestock keepers and those who make part of their living from hunting and collecting from the forest including the business community. Some local village extension officers particularly from agriculture, livestock, forestry, water, community development and health were involved in a focus group discussion session at district level. Aim of the discussions were to ascertain information from other sources (Appendix 2).

c). In-depth interview with key informants

The study involved informal interviews and or discussions with key informants particularly the technical field officers from agricultural and livestock, community development, natural resources (the forest) and water departments. The informal discussions / interviews were used to verify and seek elaborations on information from other respondents including some issues that were observed in the field.

d). Documentary review and instrumental records

The study used information on climate change, sustainable livelihoods and the forest from existing documents and records at local and global levels. The google earth particularly the IPCC 2004 and 2007 webpage together with information from the Forest Division, Community Development and the Meteorology department were very supportive and vital for this study (Appendix 4). The study used also actual rainfall data for Kwediboma village verified by The Tanzania Meteorological Agency – TMA (Appendix 5). Explicit assessment of the actual rainfall data was done for 1980, 1990 and 2000. Analysis was done for rainfall and drought as triggers for climate change and multiple livelihood systems in the area. Rainfall and temperature data was also accessed at Climate Data by Köppen & Geiger, (2010).

e). Observation

Through observation, the study verified information from questionnaires and discussions with the study sample. It was through observation that it was possible to check indigenous risk assessment and mitigation practices as coping strategies in the area. Observation also assisted the study to verify some investments, social services infrastructures and availability, as well as, effectiveness of the forest linked and other options for adaptation in the area (Appendix 3).

3.4 Data Analysis

Data from this study have been analyzed alongside: effectiveness, efficiency, relevancy, impact and sustainability. Data were analyzed alongside quantitative, qualitative and relational data from interviews, observation, focus group discussions, as well as, literature from secondary sources. A Statistical Package for Social Sciences – SPSS programme was used to work out simple mathematical calculations that were used to prepare data tables and graphs, frequencies, percentages, ratios, correlation and mean variables. Standard deviation was developed in annual frequency classes and graphs. Experience from this study indicate that qualitative information requires in-depth analysis many other sample study members in order to validate and get some meaning out of the information. Qualitative data were analyzed by involving the study sample considering also the history, social, and political implications in the area before the information was contextualized. Community forums such as schools, home family gatherings, gatherings in market centers and village assemblies for preliminary data analysis in the respective study villages. The process provided useful and focused information where data related to wealth or cost were confined to the local situation based on local experiences and the local definitions of wealth. The process of data analysis was during this study managed in a sequential order that enabled reflections and cross reference of findings from different data sources including literature review.

3.4.1 Analysis of data from questionnaire

Data from questionnaire were mostly quantitative data that were analyzed in a Statistical Package for Social Sciences – SPSS programmer to work out simple tables, graphs and charts that were used for further analysis of the data.

3.4.2 Analysis of data from Focus Group Discussion sessions

Data from Focus Group Discussions – FGD were both quantitative and qualitative. Quantitative data were analyzed by support of the Statistical Package for Social Sciences – SPSS programmer and qualitative data were analyzed by discussions with the study sample and other key persons in the community like traditional, spiritual and the sitting formal leaders in the community by the time of this study.

3.4.3 Analysis of data from in-depth interview with key informants

Despite some being quantitative, most of data from key informants were qualitative. Such data were analyzed mostly by discussions with some members of the study sample and other key persons in the community like traditional, spiritual and formal leaders in the community to verify such information.

3.4.4 Analysis of data from rainfall and temperatures

Specific location rainfall and on-line temperature records relevant for the study area were used some during discussions with community members in The North Nguu Mountains for analysis the climate (rainfall and temperature trends) in the area.

3.5 Ethical Issues

A research permit for this study was released by the Open University of Tanzania. The permit was presented to the authority in Kilindi district who introduced the researcher to the study villages. The study was conducted in collaboration with the study sample through the village government leaders, at times, the informal traditional and clan leaders including some influential persons in their respective localities. It was necessary to work close to the local traditional leaders for their traditional power and influence in convincing people to collaborate particularly when

conducting the study to the agro-pastoral communities. It was also necessary to use women leaders, as well as, female assistant researchers (enumerators) when conducting this study in order to interview or discuss with some women respondents that would have otherwise been difficult to reach through men. Nevertheless, permission to interview individuals or groups was generally requested from the individuals or groups themselves prior to the interview sessions.

3.6 Data Validity and Reliability

Validity and reliability of data from this study is ensured by effectiveness of the data collection tools. The tools and approaches used for data collection for both primary and secondary data generate valid and reliable information. Triangulation and crosschecking (validation and or verification) during data analysis strengthened data validity and reliability. Information from this study is therefore sufficiently valid, reliable and hence should be considered important and worth noting.

3.7 Data Presentation

Information generated from this study include detailed descriptions of the knowledge of rural communities particularly those living adjacent to the forest resource expressing the impact of climate change on their daily living. This information is presented in normal texts, photos, diagrams and figures. Part of the information is also presented in tables, charts and quotations.

3.8 Summary

Generally, information from interviews and discussions has been used alongside data that arise out of the researchers' feelings, impressions and judgments to present a

descriptive link between climate change, rainfall and livelihoods that are linked to the forest in the area. Analytical survey methods have been used to substantiate and verify both primary and secondary data. Data collection was generally managed partly by living and working together with communities in the study area throughout the study period. The village registration books were used to identify the study sample. With support from the study sample, livelihood zones were sketched in each of the study villages in order to identify the relevant sites for the study. A time schedule for data collection was prepared for each livelihood zone e.g. crop farming areas or livestock grazing areas etc. in each of the study villages. Data was collected through interviews and discussions including field observations involving 99.3% of the study sample. Analysis of primary data was backed up by using secondary data.

CHAPTER FOUR
4.0 PEOPLE'S PERCEPTIONS ON CLIMATE CHANGE AND LIVELIHOODS

4.1 Introduction

Chapter four presents findings on the local people's perceptions on climate change and the relationship between climate change and their daily living in The North Nguu Mountains. However, it was necessary before inquiring on their perceptions on climate change and the relationship between climate change and their daily living to first inquire on their background. The enquiry on people's background i.e. the reasons for them to move in or settle and decide to make their living in the area already gave them some hints on the environment and livelihoods in the area.

Notion of the environment including some livelihood strategies and systems in the area paved way for the people to already narrate their notion on the behaviour of weather conditions in the area. At this juncture, communities were already in a position to account for the accelerating factors for climate change and the early warning systems for climate change in the area. This information assisted to verify and or validate their knowledge on climate change and livelihoods in the area.

4.2 Settling in The North Nguu Mountains

Communities revealed during formal and informal discussions that new opportunities for them to diversify and broaden their livelihood horizons from the forest potential was the main reason for them to move in and settle in The North Nguu Mountains.

Detailed discussions verified further specific reasons for communities to move in and settle in The North Nguu Mountains to be:

4.2.1 Land and the forest potential

Communities attach potential of land and the forest for their daily living to be the driving force behind their settling and living in The North Nguu Mountains. Specific aspects mention by communities during discussions include the vast fertile arable land in the area plenty of timber and the non-timber forest products.

Goods and services from the forest that were mentioned to attracted people move in and make their living in The North Nguu Mountains include the rainfall moderation function of the forest draining water from the hills and the forest-top mountains including the valley bottoms of the hills and mountains throughout. Others include availability of timber and the non-timber forest products such as fuel wood, charcoal, wild fruits, berries, nuts and vegetables, honey, building poles, medicinal plants, grazing fields including game and game products. Generally, goods and services from the forest attracted people to settle and make their living in the area.

During detailed discussions, communities revealed further that the forest is provided by nature on land. For this therefore, the forest potential is directly linked to production and productivity of the vast arable land in the area. Communities argued that potential of the vast arable land in their respective localities is attributed to and maintained by the function and potential of the forest resource in the area. They discussed and agree further that land and the forest were and are still the baseline for livelihoods in the area.

Generally, the local communities discussed and agreed that the forest potential on land and the general environment were the main reasons for them to move in, settle and decide to make their living in their localities within their respective villages in the area. Further discussions in Kilindi and Lulago villages for example revealed also the forest and the vast arable land to created employment opportunities to individuals, families and households in the villages. They revealed further that potential of the forest on land were key to food security and a sustainable economy that attracted them to settle and make their living in the area. Text box 4.1 presents information from a key informant from Lulago village in the discussions on land and the forest potential in Lulago village during this study.

> ‘ ... sustainable livelihoods is the reason that made me to settle and make my living here in Lulago village ... the vast arable land in the lowlands downstream the forest-top mountains that is suitable for crop farming and livestock keeping throughout the year ... also ... the continuous benefits that I’m getting from the rich mountain-top forests ... just adjacent to my house here in the village ...’ (A farmer: Lulago village, 2011)

Text Box 4. 1: Land and the forest potential in Lulago village.

Source: Field Data (2012)

4.2.2 Conducive weather conditions

There are also people who moved voluntarily in The North Nguu Mountains and who attach the conducive weather conditions particularly rainfall and temperature to be the motive force behind their settling in the area. Rainfall trends and rainfall size or volume including the moderate temperatures were the main reasons for people to settle and make their living in The North Nguu Mountains. One community member

from Kwediboma village made a comment during discussions in the village that conducive weather includes sufficient and timely rainfall events accompanied with moderate temperatures. Text box 4.2 presents information on the conducive and sufficient rainfall in Kwediboma village from a community member.

> ‘ ... apart from the space for farming and livestock keeping, what attract me here is the weather condition all year through ... this allows me to invest on land all the time ... also the length of the rain seasons and the volumes of water from the rains that contributes to support life in general... the situation is attractive and it actually convinced me to stay and keep my family here ... it’s good making living here ... living here promises food security and income ... ’ (A farmer: Kwediboma village, 2011)

Text Box 4. 2: Conducive weather conditions

Source: Field Data (2012)

Figure 4.1 and 4.2 present settlements (village centres) in the study villages where communities that were involved in data collection for this study live.

Figure 4. 1: Trading centre Kilindi

Source: Field Data (2012).

Figure 4. 2: A pastoral home-Gombero

Source: Field Data (2012)

Figure 4.3 and 4.4 presents questionnaire interview and informal discussions with communities on the factors that attracted communities to move in and decide to make their living in The North Nguu Mountains when collecting data in Kilindi village.

Figure 4. 3: A key informant-Kilindi village

Source: Field Data (2012)

Figure 4. 4: Group Discussion-Kilindi

Source: Field Data (2012)

4.2.3 Other reasons

The other reasons that were mentioned to attract people to move in and make their living in The North Nguu Mountains include: potential for hunting and mining, inheritance from parents and grandparents, as well as, the country's villagization programme during the 1970's.

As revealed from this study, people's decision to settle and make their living in The North Nguu Mountains indicated further that, as habitat for game, the forest provided an opportunity for hunting, mining prosperity and collection of specific bits and pieces from game and the non-timber forest products. A few more community members in all the study villages attached their settling in their respective localities to be inheritance from their parents and grandparents. Other community members

referred to the 1970's state force behind the country's villagization programme to be the main force behind their settling in the area.

When asked to elaborate more on the villagization process, communities noted that the government requires that people move from their scattered small settlements or homesteads and to special designated communal settlements commonly known as *'ujamaa'* villages. Communities explained the villagization programme to be mainly an administrative move by the government for community development and welfare services to the people. A few other community members referred to this programme as the reason behind them settling and making their living in the area. During the discussions, a retired civil servant who was among the villagers that were involved in the discussions hinted that he knew that the villagization programme was part of the government's efforts to implement the country's 1970's decentralization process.

During discussions in Gombero village, some four elders admitted that in 1973 the district authority requested them to move from a small on farm settlement known as Komgobe just 2 km away from Gombero village to the main road. They decided to move to a different location far from The North Nguu Mountains. However, given that they were new to the place where they moved to, land was not conducive for farming as they used to do, as well as, acute water shortage. In the mid-1990s, the same people decided again, each at a different time, to move back to The North Nguu Mountains and settle again in Gombero village.

Generally, potential of the vast arable land and the forest resources together with conducive weather conditions particularly the favourable rainfall i.e. rainfall pattern,

size and or volume were outlined by communities to be the major reasons or factors behind their decision to settle and make their living in the area. This means that land, the forest and rainfall are the major livelihood assets that attracted them to settle and make their living in the area. There was, for example, an argument throughout the discussions in the area that *'no forest, no life'*. This argument was raised by community members during discussions in all the study villages and it summarized potential of the forest for living in the area. Findings from this section are similar to information from a study by Gouri (2004) where forests were found to be critical to the livelihoods of most people who settled and decided to make their living next to designated forest lands in rural Himachal Pradesh, Indonesia. Similar to information on the people from *Hima-Pradesh* who were compelled to the forest for their living (particularly on forest products and grazing), communities in The North Nguu Mountains are also compelled to make their living on land and the forest potential.

4.3 People's Perceptions on Climate Change

This section presents information on people's perception on climate change and also, the relationship between climate change and their daily living. Information from this Chapter includes data from formal and informal discussions, as well as, in-depth formal and informal interviews with key informants. During discussions, a total of 1,248 equivalent to 99.8% of the study sample attached the accelerating long term changing weather conditions to signify climate change in their localities. The long term changing weather events that were mentioned by communities include: changing rainfall (pattern and size or volume); changing temperatures; changing water levels and salinity; changing vegetation cover including the forest including

changing human and livestock health. Communities explain all these processes and conditions to lead to unsustainable livelihood strategies and systems i.e. unsustainable daily living conditions. Table 4.1 presents findings on the way that ordinary people in The North Nguu Mountains perceive climate change.

Table 4. 1: People's perception on climate change

No.	Perception on climate change	Total	%
1.	Changing rainfall (patterns and size/amount)	273	21.8
2.	Changing temperatures	107	8.6
3.	Changing water levels and salinity	87	7.0
4.	Changing vegetation cover including the forest	394	31.6
5.	Changing human and livestock health	133	10.7
6.	Changing livelihood systems hence income levels	254	20.3
TOTAL		**1,248**	**100.0**

Source: Field Data (2012)

4.3.1 Changing rainfall patterns and size / volume

A total of 21.8% of the study sample perceived changing rainfall patterns including rainfall size and or volume to indicate climate change (Table 4.2). Further information from discussions, as well as, data from the in-depth interview sessions with key informants indicated also communities perceiving changing rainfall patterns (storm patterns and size) to be changing climatic conditions in the area.

More information from discussions with communities in all the study villages revealed further that a change in rainfall patterns over time result from among other things, depletion of the forest cover that accelerates changing weather conditions by

weakening the forest's potential for rainfall moderation. Information from discussions revealed further that such processes signify climate change and have a direct impact on people's daily living in the area. Discussions revealed further that changing rainfall patterns is the most signifying factor for climate change in the area. Generally, communities agreed during discussions that changing rainfall pattern signifies climate change and has impact on people's livelihood systems.

Findings indicated further that apart from the frequently changing rainfall patterns including the rainfall size and or volume, local people in the area observe diminishing rainfall over time to result into unsustainable production and productivity of land hence crop farming and livestock, as well as, production and productivity of the forest hence timber and the non-timber forest products including game and game products all leading to food and income insecurity in the area. Information reveals further that even hunting becomes much more difficult during unreliable rainfall situations as game moves in and out for their living. Text box 4.3 presents information from a key informant from Gombero village during detailed interview when conducting this study in the village.

> ' ... before, when I was too young to move out with cattle ... my brothers used to take cattle away from home in July through November during the year for grazing and watering elsewhere ... but nowadays, we are taking cattle out from our village for grazing and watering in October and come back in March the following year ... this year they left late and they are not yet back ... I'm not sure when will we be leaving and get back cattle next year because it started raining earlier than we expected and nobody knows how long it will last ... yes, because changing in rainfall seasons in our area is automatically changing livestock mobility in search of grazing pasture and water ... ' (A farmer: Gombero village, 2011)

Text Box 4. 3: Changing rainfall patterns and size / volume

Source: Field Data (2012)

Information indicate further that changing rainfall pattern creates unemployment mostly to individuals, families and household members because people are not sure of when it rains and how long will it last for them to work in crop farms, livestock, hunting or collection from the forest.

4.3.2 Changing temperatures

A total of 8.6% of all respondents (Table 4.2) considered changing temperatures to signify climate change in their respective localities. Further information from discussions, as well as, information from in-depth interviews with key informants indicated or associated changing temperatures to climate change in the area. Information from detailed discussions with key informers for example reveals that changing temperatures signifies climate change and has a direct effect on people's daily living in the area. Further information from key informants indicates further that, high production and productivity in both crop farming and livestock keeping was experienced when temperatures rise with average rainfall. Text box 4.4 presents information on changing rainfall parallel to changing temperatures from a key informant in Lulago village.

> ' ... it was not usual to see a woman with a child on her back going inside the forest in between June and July to fetch ... firewood, fruits or wild vegetables ... just because it was too cold in the forest particularly during that particular period in the year during those old days ... children could not stand that much cold particularly in the forest ... but nowadays, women take their babies on their backs staying long with the babies inside the forest anytime throughout the year ... there is no more that much cold as it used to be in the past ... I think this is what is referred to be climate change ... !' (A farmer: Lulago village, 2011)

Text Box 4. 4: Changing temperatures in Lulago village

Source: Field Data (2012)

4.3.3 Changing water volumes and salinity levels

A total of 7.0% of all respondents (Table 4.2) considered changing water volumes and salinity levels to be part of or signify climate change. Information from discussions including that from in-depth interviews with key informants associates also changing water volumes and salinity levels to climate change in the area.

Detailed information reveals that changing water volumes and salinity levels have a direct effect on people's daily living as it results to low production and productivity both in crop farming (particularly in supplementary traditional irrigated crop farming) and livestock (cattle watering). This situation results in food and income insecurity from both crop farming and livestock keeping communities. Text box 4.5 presents information on changing water volumes and salinity to express climate change from a key informant when conducting this study in Gombero village.

> '... it becomes difficult to water cattle in our village because of the low water levels ... we've been fetching water down in extremely deep wells for watering our cattle from August to December last year... the water levels are very low and it is not fresh water as we're used to ... milking cows is very poor since we started using this water for cattle ... the boys spend time to get our cattle herd watered ... the water level is just too low ... water is salty ... it takes long to get it ... life is not good any more ... the weather is changing ... '
> (A farmer: Gombero village, 2011)

Text Box 4. 5: Changing water volumes and salinity levels – Gombero

Source: Field Data (2012)

Another key informant had similar observations when discussing with the researcher on the same issue in Kwediboma village during this study. Text box 4.6 presents

information on changing water volumes and salinity levels as expressed by a community member in Kwediboma village during this study.

> ‘ ... I don’t like to use water from the bore holes for washing white clothes because the clothes will cease to be white ... but also, we used to raise 10 bags of 100kgs of green peas in our farm plot slightly below one acre which is adjacent to the forest for the last 10 years ... nowadays we’re watering the crops using water from bore holes and we’re getting only 6 bags of the same weight in the same piece of land ... we’re thinking of shifting to raise another crop and see if we can come back to produce like it was in the past ... I think that’s why most bore holes formerly kept for domestic use have now been abandoned ... neither crop farmers nor livestock keepers use them ... I think this is something to do with climate change ... ‘(A farmer: Kwediboma village, 2011)

Text Box 4. 6: Changing water volumes and salinity levels - Kwediboma

Source: Field Data (2012)

4.3.4 Depletion of the vegetation cover including the forest

A total of 31.6% of all respondents (Table 4.2) perceived climate change as depletion of the vegetation cover including the forest. This was the most visible adverse condition that results from the long term changing weather conditions and which have a direct effect on people’s daily living as observed by communities during this study in the area.

Information from focus group discussions, as well as, data from in-depth interviews with key informants also supports information from questionnaire interview that depletion of the vegetation cover including the forest to signify climate change. Information from detailed discussions from all the study villages revealed further that depletion of the vegetation cover including the forest signifies climate change but such a process is by itself an impacting feature for climate change and it has a direct

effect on people's daily living in the area. Discussions revealed further that depletion of the natural vegetation cover including the natural mountain-top forests goes hand in hand with depletion of planted vegetation e.g. woodlots and community forests including the annual and perennial crops on the farm lands and range lands. Information from key informants reveals further that when the natural vegetation cover including the forest was rich and healthier particularly during the past, the area and the local people experienced high production and productivity of land, the forest and livestock all providing plenty of food for consumption including other products for trading that include game, timber and the non-timber forest products. Hunting was much more fruitful during such periods because of game influx from nearby areas during specific seasons that the local people know them as hunting seasons.

More information from discussions in all the study villages indicate further that depletion of the vegetation including the forest cover creates unemployment mostly to individuals, families and households in the localities. Text box 4.7 presents information on depletion of the vegetation cover including changing forest health as noted by one key informant from Kilindi village to stand for or signify climate change when conducting this study in the village.

> '...the rich and nutritious natural green cover on land depends on the weather ... it is what makes us survive ... but if no natural green cover, then no vegetables, no fruits, no timber, no rain water, no game meat, no medicine from the forest, difficult to perform ritual ceremonies ... and generally no life ... it is difficult to imagine' (A farmer: Kilindi village, 2011)

Text Box 4. 7: Depletion of the vegetation cover including the forest

Source: Field Data (2012)

4.3.5 Changing human and livestock health

A total of 10.6% of the respondents considered a change in human and livestock health to signify climate change (Table 4.2). Information from discussions and data from in-depth interviews with key informants indicated also that changing human and livestock health over a period of time that results from food scarcity for human beings, lack of fodder or poor pasture for livestock, as well as, lack of water for both the people and livestock signifies climate change in the area.

Information from discussions revealed further that reasons for changing human and livestock health in the area are always resulting from poor production and productivity of land and the forest resources thus food shortage for both the people and livestock. A key informer from Gombero village for example used the indigenous sheep at his home to illustrate how he perceives changing human and livestock health to signify climate change. Text box 4.8 presents information from the key informer during discussions when conducting this study.

> ' sheep are delicate when it comes to wet weather conditions ... health of the young in our tribal systems depend on availability and the health status of sheep in the family ... people especially the children becomes sick when it starts raining ... sheep also becomes sick when it starts raining ... but sheep is always kept to be sold when in need for money like for meeting medical bills ... but sheep is also for feeding the young and the sick ... continuous raining results in poor health for the sheep and results further in poor health for the people (the young and the sick) ... continuous drought the better the sheep and also health status of the young and the sick in the family / household ... '(A farmer: Gombero village, 2011)

Text Box 4. 8: Changing human and livestock health

Source: Field Data (2012)

The key informer who is also a cattle keeper clarified that the common diseases for the human during excessive heavy rains and also during excessive drought to be diarrhea and malnutrition. He continued saying that sheep get affected with skin, foot and mouth diseases during excessive drought whereas they purge and get thinner during excessive rainfall. He said further that young men who take cattle out for gazing are always healthy because of the milk and sheep meat intakes in their diets for herding cattle. For the key informer, changing health for the human and for livestock for a long period signifies climate change.

Detailed information from discussions including information from key informants indicated further that changing livestock health results in local people in the area to experience poor and unsustainable food and income from livestock. Some communities associate this with the local people not being able to care for the livestock and the problem of food and income security persists hence changing health of the human health. Likewise, changing human health results in the human not being able to take care of livestock and the problem of poor food intake and income security continues. Communities agreed in common during discussions that situations where the human health and that of the livestock get down or deteriorate reflects changing weather conditions or climate change.

4.3.6 Changing livelihoods hence income levels

A total of 20.3% of the study sample (Table 4.2) considered deterioration of land and the forest resources to signify climate change. Information from discussions, as well as, data from in-depth interviews with key informants support also deterioration of

land and the forest resources over a period of time to signify climate change. Detailed information from focus group discussions including information from in-depth discussions with key informants indicated that deterioration of land and the forest results from the long term changing weather conditions (another most visible adverse condition) and have a direct impact on people's daily living in the area.

Similar to depletion of the vegetation cover including the forest, as well as, the changing rainfall patterns, generally, the in-depth interviews with key informants revealed that deterioration of land and the forest resources resulted to the local people in the area to experience unsustainable production and productivity of land, the forest resources. It was, for example, revealed during this study that communities engage in crop farming both for food and trading i.e. income generation purposes. The Nguu Cooperative Union was the most prominent buyer (the market) for maize in the area. However, through the open market and free trading systems that came into practice in the 2000's, the relatively larger farmers in the area used to buy, store and transport excess maize grains in the area before they access potential buyers from nearby urban markets. Traders invaded the maize market during the period of this study making it difficult to trace marketing data for maize in the area.

However, it was possible during this study to trace production and selling of maize by farmers in the area that indicated also maize production and productivity level in the area after every 10 years for a period of 40 years since 1982 to the year 2012. A look in the marketing data for maize grains in the villages through The Nguu Cooperative Union was aimed at developing a quick glimpse as evidence of the

impact of climate change in crop production in the area. Table 4.2 presents selling of maize for the period of 1982, 1992, 2002 and 2012 as recorded at Kilindi, Kwediboma, Gombero and Lulago village government offices by or through agents to the Nguu Cooperative Union.

Table 4. 2: Selling of maize 1982, 1992, 2002 and 2012

	SELLING OF MAIZE (IN 100 KGs BAGS)			
VILLAGE	1982	1992	2002	2012
Kilindi	748	687	707	735
Kwediboma	9,611	8,810	6,031	4,838
Gombero	814	786	718	695
Lulago	715	686	536	494
TOTAL	11,888	10,969	7,992	6,762

Source: Field data, (2012)

Communities noted during discussions on production and productivity in crop farming that, there is still the possibility of increasing acreage (area under maize production) in order to increase production maize production in the area. However, still proper application of recommended agronomic skills that include cropping patterns, use of inorganic manuring, use of minerals and organic fertilizers, use of pesticides and insecticides, as well as, use of recommended high yield and drought resistance seed varieties can still be used to increase maize production in the area.

However, the farmers in this study consider all these actions to be linked directly to the marketing aspect of maize production. For the farmers who were involved in this study mentioned the supportive and favourable weather conditions particularly

rainfall (availability of water for plants) and good temperature remains exclusively essential for crop productivity particularly maize in their localities. Only two farmers in Lulago village and other two in Kilindi village expressed the idea of improved irrigation for increased farm crop production. Unsustainable production and productivity of land and the forest resources, including uncertainty in rainfall were therefore identified to lead further to unsustainable livelihoods causing food insecurity, low income and hence poverty. The situation provided also low supply of products for trading in the markets. Also, since land and particularly the forest provides habitat for game, deterioration of the land and the forest affects also availability of game products. The situation created further unemployment to most individuals, families and households members whose livelihoods are linked to land, the forest and game resources in the area.

Moreover, further information from key informants reveals that deterioration of land and the forest is the strongest impacting factor for climate change to the daily living of most of the people that include individuals, families, groups and households in the area. Generally, discussion from all the study villages concurred with information from questionnaire interviews that deterioration of land and the forest signifies climate change and has impact on livelihood systems including food and income security to people in the area. One key informant in Kwediboma village, for example, stated during discussions that land and the forest are the major livelihood assets in Kwediboma village. The key informant stated further that experience shows that deterioration of land and the forest have a direct and negative influence on rainfall pattern including the storm size and or volume in the village. The informer,

therefore, conclude that deterioration of land and the forest resources which have a direct influence on rainfall signifies or is part of climate change in the area.

Generally, information from discussions from all the study villages together with information from interview with key informants concur with information from questionnaire interviews that changing human and livestock health signifies climate change and has impact on livelihood systems including food and income security. It was further revealed that a situation of changing health to both the human and livestock leads to a further decline in livestock production and productivity.

The situation provides unsustainable food and income including trading products from livestock and the subsidiary livelihoods to livestock keepers due to the human not being able to work properly. This contributes further to creating unemployment mostly to individuals, families and households particularly those who depend directly on livestock in the area. Communities indicated their perceptions on climate change through rainfall variability that triggers unsustainable livelihoods in the area. The impact of climate change on livelihoods in the area corresponds to and verify similar findings from Smith and Troni (2004).

Generally, communities in The North Nguu Mountains perceive the most visible adverse condition that results from the long term frequent changing weather conditions and which have a direct impact on their daily living to signify climate change. Findings from this study are also in line with information from a study by Mansourian *et al.* (2009), as well as, Reid *et al.* (2004) that the impact of climate

change is solely linked to the health of the natural resources base such as land and biodiversity that supports livelihoods.

4.4 Accelerating Factors for Climate Change

In the process of assessing people's perception on climate change and the relationship between climate change and livelihood mechanisms, the study examined people's knowledge on the accelerating factors for climate change. Community members that responded to the questionnaire interview observed that: pressure on the forest; pressure on land; pollution; the poverty situation, as well as, some natural factors such as the universe's systems from the atmosphere are among things that accelerate climate change in the area. Table 4.3 presents responses from the questionnaire interview respondents from all the study villages during this study.

Table 4. 3: Factors that induce / accelerate changing weather conditions

No.	Inducing/accelerating factor	Kwediboma	Kilindi	Gombero	Lulago	Total	%
1.	Pressure on the forest	87	76	80	59	302	24.2
2.	Pressure on land	158	102	131	87	478	38.2
3.	Pollution	42	23	32	20	117	9.4
4.	Poverty	56	34	40	31	161	12.8
5.	Natural factors	61	46	53	32	192	15.4
Total		404	281	336	229	1,250	100.0

Source: Field Data (2012)

4.4.1 Pressure on the forest

A total number equivalent to 24.2% of respondents to the questionnaire interview (Table 4.3) indicated pressure on the forest to be the leading factor that induce and accelerate climate change in the area. Information from focus group discussions, as well as, data from in-depth interviews with key informants from all the study villages supported that pressure on the forest is an inducing and accelerating factor for climate change in their respective localities.

Detailed information from discussions from all the study villages for example reveals further that pressure on the forest increases people's and livestock requirements from the forest and hence over utilizing the forest. This process lowers the forest potential for supporting livelihoods and even as an option for adaptation in the area. Further information reveals that pressure on the forest lowers the forest health hence creating unemployment to individuals, groups, families and households that depend on the forest linked livelihoods such as use of timber and the non-timber forest products, services provided by the forest, as well as, game and game products for their living. Detailed information particularly from Lulago and Kilindi villages attach pressure on the forest to low production and productivity of the forest hence low supply of the non-timber forest products for both home consumption and trading. Nevertheless, as habitat for game, pressure on the forest affects also availability of game causing not only scarcity in game products for use and trading but also potential for hunting in support to living for some community members in the area. But this has effect to employment and thus income from visitors to the forest and game for communities especially the youth in the area.

Text box 4.9 presents information on pressure on the forest as presented by a key informant from Gombero village during this study. The informer is a community member who earn living out of the non-timber forest products. The informer do not see any other option for keeping the family if not the forest use.

> '... there is no way I can feed my family throughout the year without visiting the forest ... my daughter wouldn't have done it to the Teacher's Training College in a far way down town if not playing around with the forest ... we paid for her tuition fees we also paid for her return fare ... boarding charges ... medical and examination fees not forgetting ... and we're still surviving while we basically have nothing neither from our crops farm nor our poultry farm, no the little livestock that we're keeping at home for this year ... ' (A farmer: Gombero village, 2011)

Text Box 4. 9: Pressure on the forest

Source: Field Data (2012)

4.4.2 Pressure on land

A total of 38% of respondents from the study villages (Table 4.3) indicated that pressure on land is the root cause and lead factor that induce and accelerate the long term changing weather conditions in the area. Information from focus group discussions, as well as, data from in-depth interviews with key informants support also pressure on land to induce and accelerate climate change in the area. Further information from discussion sessions from all the study villages concurs with data from the questionnaire interview that indicate pressure on land to be the inducing and accelerating factor for climate change in the area.

Further information from discussions with key informants revealed that pressure on land makes the land resource to be scarce thus creating unemployment to individuals, groups, families and households that depend on land and the forest for their living.

Detailed information from both discussions and the interview with key informants indicate further that pressure on land results to land use conflicts parallel to low production and productivity of the land resource. This situation affects more crop farmers, livestock keepers and all those who depend directly or indirectly on land for their living in the area. Information reveals further that pressure on land extends to accelerated pressure on the forest also. Communities attach pressure on land to low production of food products from crop farming and livestock keeping, as well as, products for trading that include crop farming and livestock products that are significant products for trading in the area.

4.4.3 Pollution

There were no measures of pollution that were taken during this study. However, a total of 9.4% of respondents (Table 4.3) indicated pollution from chemical waste that were being used in the villages and in nearby big towns like pollution from waste plastic materials from the trading centres and weekly markets, oil, petroleum fluids and waste industrial liquids and materials, waste insecticides, pesticides and fertilizers commonly used by communities particularly crop farmers and the livestock keepers are among the factors that accelerate climate change in the area by hindering the natural regeneration of the biodiversity in the area. Information from discussions and in-depth interviews with key informants from all the study villages support the observation that pollution especially from burning the forest and chemical waste is among the factors that accelerate the impact of climate change in their respective localities. Information from discussions in all the study villages for example revealed that pollution particularly from chemical waste retards the natural

regeneration of the vegetation cover including the forest. The situation in turn contributes to loss of the natural vegetation including the forest and hence accelerate the process of climate change.

A key informant from Kilindi village made a comment accusing the government and the other stakeholders of the forest resource for bringing exotic tree species *Eucalyptus* tree spp. popularly known in the village as '*mikaratusi'* or '*miti ulaya'* for planting in the boundaries of the protected forests including enrichment planting in open spaces on farms and in settlements. The key informant from Kilindi village noted that water levels in rivers, streams and bore holes in the village went down since they started planting such trees in the village. The informer continue saying that the village area is becoming drier than before and the reason is because of the new tree species brought in the village by the government. The key informer refer this as kind of plant pollution in the village.

Another key informer from a pastoral family in Gombero village noted that cattle dips are good for livestock because they control tsetse flies including all the other livestock disease transmitting insects. However, when a cattle herd goes out in the field for watering or grazing immediately after the dipping process, remnants of the dip vaccine drops from cattle drops down destroying grass and shrub (the natural vegetation) offspring. The key informer adds that the whole place is in the long run becoming dry and polluted i.e. no or retarded natural growth of the vegetation cover. The key informer emphasizes that this is kind of chemical pollution. Generally, all kinds of pollution as perceived and reported by communities during this study are considered as strong driving factors for accelerated climate change in the area.

4.4.4 Poverty

A total of 12.8% of respondents (Table 4.3) observed poverty (income poverty) to be a factor that induce and accelerate climate change in the area. Detailed information from discussions including data from in-depth interviews with key informants from all the study villages align with information from questionnaire interview that poverty is an inducing cum an accelerating factor for climate change in their respective localities in the area.

Detailed information from discussion in all the study villages for example revealed further that income constraints (low income) to communities aggravates land and the forest as livelihood assets available readily in the area. Such a situation lowers the potential for sustainable income generation livelihoods, as well as, options for adaptions in the area. Further information from the study villages reveals also that apart from income poverty there is also poor entrepreneurship knowledge on the forest resource amongst communities being intensified by the local and national level policies. Communities attach all these to intensify income poverty and hence accelerate the process of climate change in the area because communities have no means to invest on land and forest management.

A key informer from Lulago village in the middle of the North Nguu Mountain Forest Reserve admitted that the forest is good for maintaining good weather in the area particularly on the rainfall moderation aspect. But the forest is also a readily available asset for people's living with income generating potential in the village. However, the key informer admits to the fact that communities are the main

destruction agents of the forest resource in the village simply because they lack other sources of income to make their living. The key informer from Lulago village for example admits people to support living in the village mostly through hunting including honey hunting for home consumption and selling including collecting in the forest. The key informer gives an example further that people sometimes use fire for crop farming or when going for hunting or collecting from the forest. This is aimed at having good crops or to have good honey harvests or prey.

However, forest fires sometimes result in major damage to the forest resource. The key informer claimed during interview when conducting this study that people have been using fire since immemorial periods and there are poor signs of reversing the trend because people do not have enough capital to manage modern investments as an alternative to using fire for earning their living from the forest.

4.4.5 Natural systems

Unexpectedly, during in-depth interviews and discussions with the key informers, the study acquired a huge volume of un-prompted data that was in line with the theme under study. This information was generally people's own perceptions on the positive or negative influence of the universe's natural systems in influencing (accelerating or slowing down) the process of climate change in the area. When requested to define the universes natural systems during this study communities explained the system to include timing, positioning and movement and side view of some big planets from specific sign posts or position of the villages. The explanations included rainfall patterns, occasional mist and fog on the mountain-top

forests together with unusual sunshine and temperatures. The study picked up the new un-prompted information from Lulago and Kilindi villages and bring it to the other respondents in the other two villages i.e. Kwediboma and Gombero villages to share it and possibly add more information on the natural issues.

Despite the in-depth discussions during the study, communities could not agreed in common that the human factor has an influence on the universe's natural systems i.e. The universe's natural systems were different from those that were being influenced by the human factor. However, a total of 15.4% of all respondents to the interview questionnaire observed that the universe's natural factors were among the inducing and or accelerating factors for climate change in the area as presented in Table 4.3.

So as to ease analysis of unprompted natural factors, the study separated and grouped all responses under the natural factors into two groups. The first group was again named under natural factors where the aspects were purely universe's natural systems that include timing and positioning of the side view of some big planets from the position of the villages that scored again 15.4% of the total studied sample and the other group was of the factors that were influenced by the human that scored 84.6% of the whole studied sample.

Figure 4.1 presents streamlining of the natural and human induced factors (that were perceived by communities from unprompted data during this study). Factors that were perceived by communities to be inducing and or accelerating climate change in specific localities within The North Nguu Mountains.

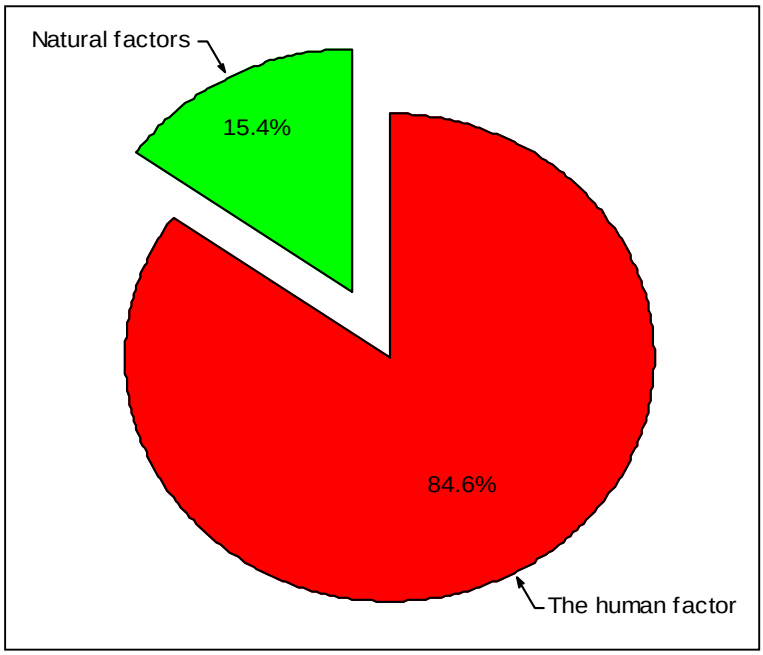

Figure 4. 5: Natural and the human factors for climate change in The North Nguu Mountains

Source: Field Data (2012)

As indicated in Table 4.3, a total of 15.4% of respondents observed natural factors to accelerate climate change in their localities. A further study on the natural factors that communities refer them to as factors that induce or accelerate climate change include location specific issues. For example, during discussions in Lulago village, changing position and location or side-view of some big planets that include the sun, the moon and some two big reddish glittering stars viewed at different positions from the village was brought up several times by communities from different age levels i.e. the youth group, adults and elders. Similar information regarding the big planets was revealed in all the study villages with a slight inconsistency in location and side view of the planets from the local view position.

The other factors that were mentioned to induce and or accelerate climate change in all the study villages include an alternating rainfall patterns between the forest top highlands with limited livelihood processes and the valley bottom lowlands with highly packed livelihood processes and also, the frequent and unexpected changing of moisture contents in the air alternating between the lowlands and the highlands. Communities considered and believed all these to be normal natural systems that induce or accelerate the process of climate change.

Detailed discussions of the information as presented by communities in all the study villages revealed that the alternating rainfall system between the forest top highlands with limited livelihood processes and the valley bottom lowlands with highly packed livelihood processes is partly influenced by the temperature systems between the highlands and the lowlands intensified by pressure on the forest. A key informer from Kwediboma village for example maintained during discussions that the more it rains on the mountain-top forests, the more productive becomes the downstream farm plots whereas the long it becomes dry on the mountain-top forests the less productive becomes the downstream farm plots. The key informer maintains also that this situation is a natural circle system. Text box 4.10 presents information on the natural systems from a key informant in Lulago village.

> ‘ ... the more it becomes windy during the planting season ... the less will be the rains .. and the less will be the harvests ... but heavy windblown, sun shine and rainfall in our village depend on the positions of the big planets particularly the sun, the moon and the ‘*reddish glittering big star*’ at midnight in the north of where we’re standing now... this happens only once after every two years ...’ (A farmer: Lulago village, 2011)

Text Box 4. 10: Natural systems

Source: Field Data (2012)

Communities got some difficulty in differentiating the natural systems from the manmade (the human influence) factors that influence climate change in the area. Some community members put more weight on the manmade factors in their localities than the natural systems. Text box 4.11 presents more information on systems resulting from livelihood strategies as expressed by a key informer in Lulago village during discussions.

> ‘ ... some factors that accelerate changing weather conditions here in our village can be controlled ... unnecessary forest fires, for example, cause changing the usual natural behaviour of our forest, rainfall and temperatures.... This cannot be regarded as a natural system.... rather a manmade..... ’ (A farmer: Lulago village, 2011)

Text Box 4. 11: Human influenced systems

Source: Field Data (2012)

4.5 Early Warning Systems (EWS)

Table 4.4 presents responses on Early Warning Systems (EWS) from communities in The North Nguu Mountains.

Table 4. 4: Early warning systems in The North Nguu Mountains

No.	**Early Warning system indicator / factor**	**No**	**%**
1.	Changing rainfall (storm pattern and size)	282	22.6
2.	Changing temperatures	149	11.9
3.	Migration including migration of game and birds	194	15.5
4.	Shedding, unshedding and sprouting of trees	190	15.2
5.	Frequent failure of wild fruits, berries and vegetables	157	12.6
6.	Frequent livestock diseases	152	12.2
7.	Drought	126	10.0
TOTAL		1,200	100.0

Source: Field Data (2012)

Generally, issues that were perceived and brought up by communities to be the early warning systems for climate change during interview were mostly rooting from people's own knowledge and experiences on the location specific long term changing weather conditions in their specific localities. A total of 1,200 respondents equivalent to 96% of the study sample observed changing rainfall (storm pattern and size); changing temperatures; migration including migration of game and birds; shedding, unshedding and sprouting of trees; frequent failure of wild fruits, berries and vegetables; frequent livestock diseases and drought to be the early warning systems for climate change in their respective localities within The North Nguu Mountains.

4.5.1 Changing rainfall pattern and size / volume

Generally, a total of 22.6% of respondents considered changing rainfall patterns i.e. storm pattern and storm size over time to be the common early warning system for the short, medium and long term changing weather conditions in their localities. Frequent changes in storm patterns and size (amount or volume of the rainfall) was perceived by communities to be an early warning system – EWS for climate change in the locality. Generally, information indicate that changes in rainfall patterns, sizes and or volume over time to be a warning system for climate change. Text box 4.12 presents information on rainfall by a respondent from Gombero village.

> '... when the short rains last longer than expected ... then we normally expect the long rains thereafter, to take a very short period ... consequently, the dry spell in the following season will also take longer ... but if the short rains take shorter time and become very light than expected ... then we expect strong long rain storms in a very short period ... ' (A farmer: Gombero village, 2011)

Text Box 4. 12: Changing rainfall as an early warning system

Source: Field Data (2012)

The main close variation during discussions with communities in this study was the inconsistency in timing and volume of the rainfall events to indicate changing weather conditions as an early warning system for climate change.

4.5.2 Changing temperatures

Generally, with exceptions of rainfall, there was nowhere the study got precise data on temperature neither as a primary nor secondary data during the time of this study. However, a total of 11.9% of respondents considered changing temperatures to be an early warning system for changing weather conditions or climate change. The cold and warm temperature in this study are rated by location based weather conditions in the area. Text box 4.13 presents information on changing temperatures as an early warning system for climate change by a key informer from Lulago village.

> ‘ ... I never saw a woman when I was still young here in our village going to fetch water early in the morning with a baby on her back or shoulder..... the weather was chilly cold early in the morning and late in the evening ... it is only nowadays that women can take their babies on their backs and shoulders all the times throughout the year to fetch water ... this was not possible ... and was not even allowed by the elders in the past ... ’ (A farmer: Lulago village, 2011)

Text Box 4. 13: Changing temperatures as an early warning system

Source: Field Data (2012)

4.5.3 Game and bird migration

A total of 15.5% of respondents considered migration of specific game and bird’s species to be an effective early warning system for climate change in their respective localities. Text box 4.14 presents information from a key informer from Gombero village on game migration and the early warning systems in the village.

> '...animals like *hyena* and bird like '*kwale'* (pigeon family) are normally found in bottom valley open spaces ... but when you find such animals and birds moving up to the mountain tops then it is a signal of heavy rains or long dry spell in the near future ... there are also specific kinds of birds '*watolondo'* (very small birds) which are always near settlements in the village adjacent to the mountain top forest. Such birds never get inside the forest ... but when you find such birds coming close to rivers down to the lowlands bottom valleys, then expect heavy storms ... and probably flooding in the area very soon ... ' (A farmer: Gombero village, 2011)

Text Box 4. 14: Game and bird migration as an early warning system

Source: Field Data (2012)

4.5.4 Shedding and unshedding of specific tree species

Trees are found everywhere in The North Nguu Mountains. Communities revealed during this study that flowering including shedding and un-shedding of the mountain-top forests, remnant trees in crop farming lands, grazing or range lands, as well as, trees found in settlements are all indicators providing as an early warning system for impending weather that in the long run accelerates climate change particularly rainfall within and in the neighbouring areas surrounding. It was revealed more during discussions that it is the duration of such processes i.e. flowering, shedding and unshedding of specific trees which determines changing weather conditions in the specific localities.

A total of 15.2% of respondents considered and agreed that specific flowering, shedding and unshedding of a particular type of trees like the ordinary mango tree *'magifera indica'* that are found in almost all the villages within the North Nguu Mountains and the local wild 's*ambu'* tree '*allanblackia stuhlmannii'* found in the higher peak forest-top mountains are strong indicators for climate change within and

in surrounding areas. Text box 4.15 presents information from a key informer on the flowering, shedding and unshedding of specific tree species in Kilindi village.

> ‘ ... actually, it is the higher and strong flowering intensity of the ordinary mango tree that takes longer than the time that we’re normally used to ... that indicate high rainfall (thunderstorm) i.e. a heavy downpour with big storm sizes or volumes and some lighting. However, when you see a slow but higher and strong flowering intensity of the wild *sambu* tree ... then what follows will be a long dry spell expected to last longer in the area ... ‘(A farmer: Kilindi village, 2011)

Text Box 4. 15: Shedding and unshedding of specific tree species

Source: Field Data (2012)

4.5.5 Frequent failures of wild fruits, vegetables and berries

Generally, a total of 12.6% of respondents considered frequent failures in harvesting wild vegetables, fruits and berries as an early warning system for changing weather conditions in the area. Text box 4.16 presents information from a key respondent who used to collect wild vegetables, fruits and berries from the forest mostly for own consumption and trading in Kilindi village.

> ‘... frequent failures of specific wild fruits like the local ‘*ngobe’*, *‘ntundwi’ and ‘sambu’* fruits including wild vegetables such as ‘*mphwimbiji’ and ‘kungujulu’*, as well as, berries like ‘*masamayu’* is a clear indication of a long dry season in the next dry spell ... actually when we experience a low flowering intensity of a *sambu* tree during the dry season, it is a clear indication of the next rain season to last long and prolong beyond the expected period ... ‘(A farmer: Kilindi village, 2011)

Text Box 4. 16: Failure of wild fruits, vegetables and berries

Source: Field Data (2012)

4.5.6 Frequent livestock diseases

A total of 12.2% of respondents to the questionnaire interview considered frequent livestock diseases to be a strong possibility for climate change i.e. an early warning

system for climate change in the area. Text boxes 4.17 and 4.18 present information on livestock diseases from Kwediboma and Gombero villages.

> '... I think frequent livestock diseases is linked more to poor veterinary services and poor application of veterinary packages ... last year, I consulted our veterinary agent for my two milking cows ... my neighbour lost all his milking cows from similar problems ... the agent prescribed me a package of vaccination drugs and some advise on feeding and watering the cattle but I still lost all my cows in a similar situation like my neighbour ... I think livestock diseases has something to do with climate change in this area ... ' (A farmer: Kwediboma village, 2011)

Text Box 4. 17: Frequent livestock diseases - Kwediboma

Source: Field Data (2012)

> ' ... cattle calves are normally left at home when cattle are sent out for grazing and watering ... if calves get sick more frequently ... then it is an indication of *tsetse flies* close to settlements ... also goats are normally not doing well during the wet seasons ... but if they're still not doing well during the dry season, then the dry spell will not to last long ... all these are indicators for a changing weather condition ... ' (A farmer: Gombero village, 2011)

Text Box 4. 18: Frequent livestock diseases - Gombero

Source: Field Data (2012)

Generally, information from discussions on the early warning systems with communities focused on specific events or features on particular behaviour e.g. appearance of the sun, the moon and some other big stars including rainfall and drought seasons that influence the environment in specific periods of time and for specific locations. Based on their experiences, communities revealed information on early warning systems events or features to mainly indicating disaster risks from changing weather conditions or changing climatic features and or conditions in their

respective localities. More information was revealed through story telling by communities in the light of their knowledge on the early warning systems in their localities. The study invited also tales from the elders including information on traditional beliefs, norms and values that were focused on climate change, livelihoods and the forest resource.

4.6 Weather Broadcast as an Early Warning System

Communities considered weather broadcasting as a very important aspect but operating in a conventional approach hence not adhered to by communities carefully. Giving some comments on weather broadcasting by the media particularly on rainfall, a key informant from Kilindi village gave a story during in-depth-interview that though not very much reliable, weather broadcasting by the media is the only formal early warning system for impending weather in the area. The key informant argues further that weather broadcasting through the news media was and is still the only and mostly reliable weather information in Kilindi village.

Information during discussions indicated further that despite the conventional weather broadcasting system, there are specific local events that communities understand them to be early warning systems for climate change in their localities. Communities find such events or specific natural phenomenon to still be useful, reliable and more effective as early warning systems for impending weather in their localities. However, although very useful for the ordinary people in the village, still not everyone in the village is in position to access the service easily. More comments from the key informant are presented in Text box 4.19.

> Weather broadcast is a useful and effective early warning system for us. For example in early September 2012, TMA announced that the short rains for the year 2012 were to be expected in the first week of October. This was a useful information for us because we prepared ourselves and it happened exactly like what was announced. But many people suffered because they could not get the broadcasts in. (A farmer: Kilindi 2012)

Text Box 4. 19: Weather broadcast as an Early Warning System for impending weather as experienced in Lulago village.

Source: Field Data (2012)

4.7 Location Specific Early Warning Systems

Location specific early warning systems were very useful for this study as they trace back and substantiate understanding and follow up as a means of adaptation or managing climate change by the local communities in the area.

4.7.1 Specific bird sound

Text box 4.20 presents views of a key informer from the vicinity of The Nguu Forest Reserve in Lulago village on the Early Warning Systems for climate change.

> There are specific bird species here in Lulago village locally known as '*vinkhwembe*'… when such birds migrate inside the forest then it is a signal for a heavy rain and therefore farmers start preparing their crop fields for planting (A farmer: Lulago village, 2011)

Text Box 4. 20: Bird migration as an Early Warning System for climate change as experienced in Lulago village.

Source: Field Data (2012)

4.7.2 A rise or fall in temperature parallel to a clear sunshine

Experience from a key informer from Gombero village on the extended changing weather conditions to the rise and fall in temperature as presented in Text box 4.21.

> On average the temperature here in Gombero village is not very cold, not very warm ... it is moderate throughout the year...but when the temperature becomes high with a bright clear sunshine in the morning then expect a heavy downpour in the night ...' (A farmer: Gombero, 2012)

Text Box 4. 21: Changing temperature as an early warning system in Gombero village

Source: Field Data (2012)

4.7.3 Heavy storm with ice drops

Communities consider variability in rainfall patterns together with abnormal weather behaviour such as heavy rains with ice drops to be an indicator for changing weather conditions. Text box 4.22 presents information from Kwediboma village.

> '... last year for example, we had very heavy rains along with ice drops throughout the annual rains ... in turn, this year we're having a long dry spell that overlap the ordinary short rains season ...' (A farmer: Kwediboma village, 2011)

Text Box 4. 22: Heavy storm with ice drops

Source: Field Data (2012)

4.7.4 Light showers on a sunshine

Text box 4.23 presents information from a farmer in Lulago village

> '... unlike the heavy storm with ice drops ... if a clear day with a clear sunshine close to the rain season is interrupted by some light showers with no heavy clouds on the mountain-top forests ... then this is a clear indication of the expected long rains to be with heavy storms interrupted by short periods of sun shine ... '(A farmer: Lulago village, 2011)

Text Box 4. 23: Light showers on a sunshine

Source: Field Data (2012)

4.7.5 Thunder storms

Key informer from Lulago village said during discussions in the village that thunder storms have since immemorial times been known to be signifying prolonged drought after the rains. Text box 4.24 presents the key informer's notion on thunderstorms as an early warning system for the changing weather condition and future climate change in Lulago village.

> There used to be very strong thunder storms inside the forest on top of Kilindi Mountain that indicate heavy rainfall. People were going around shouting and celebrating showing their appreciation and thus giving thanks for the rains but also reminding themselves to be prepared for the expected dry spell thereafter. (A villager: Lulago 2012)

Text Box 4. 24: Thunderstorms as an indicator for the changing climate in Lulago village.

Source: Field Data (2012)

4.7.6 Availability of certain wild fruits, nuts and berries

During informal interview with a key informer from Lulago village, it was revealed that people spent much of their time during crop farming off seasons collecting wild vegetables, fruits, nuts and berries from the forest. There are specific nuts locally known as *'sambu'* from *'allanblackia stuhlmannii'* found in the higher altitudes of the Nguu Mountain Forest Reserve. Nuts from the *sambu* tree were processed into cooking fat or cooking oil.

This product is normally for sale and part of it spared for family consumption. The informer associates availability of the nuts each year with availability and amount i.e.

volume or size or pattern of rainfall for the next annual rainfalls in the village. Generally, specific features, events and or conditions that are associated with changing weather conditions vary from one specific locality to the other. For example, features, events and weather conditions that are expressed by those staying on Mountain tops like Lulago village differ from features or weather conditions expressed by those staying on valley bottoms like Gombero, Kilindi and Kwediboma villages. This also depend on the side of the villages i.e. wind ward and lee ward.

Table 4.5 presents a summary of the early warning systems as discussed and agreed by communities in all villages during this study.

Table 4. 5: Traditional early warning systems

Specific features, events, conditions	**Climate / weather**
Early darkness (short day)	Cold dry
Late darkness (long day)	Warm dry
Early daylight (short night)	Warm
Late daylight (long night)	Cold
Sunset further in the south	Cold and rainy
Sunset overhead	Moderate
Sunset further in the north	Cold and windy
Rains with thunder storms	Short storm
Rains with no thunderstorms	Long storm
Rains with ice blocks	Short storms
Fog on mountain tops only	Wet windy
Fog on valley bottoms only	Cold wet
Fog on mountain top or valley bottoms	Dry windy
Rainfall and sunshine at the same time	Dry warm
Game inflow to the forest	Flooding
Game outflow from the forest	Drought

Source: Field Data (2012)

4.8 Summary

Generally, potential of the vast arable land and the rich forest resource together with conducive weather conditions including plenty and timely rainfall were outlined by communities to be the major reasons or factors for them to settle and make their living in The North Nguu Mountains. Therefore most of the people in The North Nguu Mountains are compelled to the arable land, the forest and rainfall for their living. This study revealed also that communities understand both the contemporary early warning systems such as weather broadcasting including the indigenous systems such as flora and fauna including weather and atmospheric systems. They also noted the root causes of climate change to be mainly the human factor. By attaching climate change to their daily living, this study revealed that communities perceive climate change to be the accelerating long term changing weather conditions thus affecting their daily living. The long term changing weather events that were mentioned by communities include changing rainfall (pattern and size or volume), changing vegetation cover including the forest, changing temperatures, changing water and salinity levels including changing human and livestock health. Communities explained all these processes and conditions to lead to unsustainable livelihood strategies and systems in the area.

CHAPTER FIVE
5.0 SIGNIFICANCE OF CLIMATE CHANGE THROUGH INSTRUMENTAL RECORDS

5.1 Introduction

This chapter presents results with detailed discussions on the impact of climate change on rainfall through analysis of actual rainfall data in The North Nguu Mountains. Information in this chapter is presented in two sections: section one presents information on the impact of climate change by observing the rainfall trends (patterns) and volume (size). The second section presents the impact of climate change by observing temperature performance in relation to rainfall in the study area.

The actual rainfall data (daily storm records) used in this study was recorded at the Roman Catholic Mission centre in Kwediboma village and verified by The Tanzania Meteorological Agency – TMA (Annex 5). Temperature data that have been used for this study were drawn from on-line sources. This chapter therefore, analyzes and or validate local communities feelings on the impact of climate change on livelihoods from rainfall i.e. patterns (trend) and size (volume) parallel to temperature.

Generally, information from this chapter lays down the basic foundation necessary for establishing and documenting the necessary information that complement, verify and or validate primary data related to the impact of climate change on rainfall and livelihoods in the area as set out in the second objective of this study. Moreover,

since rainfall is one of the forest ecosystem benefits that provides water (as a product of the forest ecosystem), information from this chapter is generally laying down the necessary information for establishing and documenting the impact of climate change on the rural forest linked livelihoods in The North Nguu Mountains as set out in the main objective of this study.

5.2 Rainfall Situation in The North Nguu Mountains

Preliminary findings from this study indicate rainfall to be among the main source of water and hence fundamental to livelihoods in The North Nguu Mountains. Communities indicated further that rainfall variability is the most significant trigger of livelihood risks and uncertainty on livelihoods in the area. Despite the general trend of deterioration of the forest potential in the country, there have been no significant studies exploring the link between climate change and rainfall with a bearing at livelihoods in the area. However, given the role and importance of rainfall for provision of water to livelihoods in the area, a study on the actual data on rainfall provide a general insight on the impact of climate change on livelihoods in the area. Indeed, findings from the assessment of the primary rainfall data in the study area for this study corresponds to and verify similar findings from Smith and Troni (2004) who revealed that generally, poor people in rural livelihoods depend more on ecosystem goods and services such as water from rainfall for their living.

As mentioned before, there have been very few studies exploring the link between rainfall and livelihoods with a bearing on climate change in The North Nguu Mountains. However, there exist some conventional literature that provide The North

Nguu Mountains to be receiving a bimodal rainfall pattern. On the contrary, information from the local community on the ground provides the area to be receiving three (3) rain seasons i.e. storm events that include the short rains *'mvua za vuli'* from mid-October to mid-December, the long rains *'mvua za masika'* from March to June, as well as, the annual rains *'mvua za mwaka'* from January to February. The area experiences the dry spell from July to September. Based on such knowledge jam, the researcher decided to assess rainfall i.e. storm i.e. rainfall trends and volumes in the area.

5.3 Rainfall Data Analysis

It was a bit difficult to make such an assessment because rainfall data was not precisely managed in most villages in the area. However, since rainfall (on its function as the sole water source in The North Nguu Mountains) was found to be a basic livelihood asset in the area and therefore, it was necessary to assess rainfall so as to generate useful information for the study. The study managed to get actual rainfall data recorded at Kwediboma village that was supplied by Tanzania Meteorological Agency – TMA. The study used rainfall data that was recorded at Kwediboma village to establish trends in rainfall patterns and rainfall sizes over a specific period of time so as to trace evidence (if any) for climate change in the area.

Focus of the analysis considered ground water recharge and water flow, as well as, rainfall run-off as the basis for rainfall triggered land cover systems such as soil-water for crop farming, run-off for multiple use systems, natural vegetation regenerating including sediment flow, as well as, water balance for multiple

livelihood systems. The researcher considered strongly results from conventional simulation and modeling including extrapolation and calibration processes on modern software packages. Working out to understand rainfall patterns based on such methodologies has traditionally relied upon monthly data or other such summaries. However, the researcher decided to use rainfall records for a period of 30 years recorded at intervals of 10 years i.e. recorded in 1980, 1990 and 2000 only.

The researcher decided for this methodology to define a day as rainy if it gets any amount (SIZE) of rainfall from any amount of rainfall events (STORM). The measuring unit for the first analysis was one year (12 months) whereas, the measuring unit for the second analysis will be ten consecutive years (10 years). No use of any sophisticated software package in analyzing the measurements (at this stage) apart from additions, subtractions and divisions.

However, it might be of interest and is possible to go further into standard deviations and use of ‘Chi-Square’ in the analysis. Note that a rainfall event was counted as a storm whereas, each year was taken as a single unit independent from the other years. The measuring unit for the analysis was one year (12 months). Note that each month with or without rain was taken as a single unit independent from the other months for a one year analysis whereas, each year is again taken as a single unit independent from the other years. Analysis is made on days before the first storm, days between storms and storm sizes.

Analysis of days before the first storm will provide evidence for a shift of, consistency or inconsistency of start of the storm events whereas, analysis of days

between storms will provide evidence for a shift of, consistency or inconsistency of start of the dry spell (drought) as evidence for climate change. The assessment was specifically on:

a) Analysis of the rainfall records (storm pattern and storm size) for the annual, long and short rains recorded after every 10 years for a period of 30 years

b) Analysis of time span before the first storm for each storm pattern i.e. annual, long and short rains recorded after every 10 years for a period of 30 years

c) Analysis of the time span between storms i.e. time before the next storm for the annual, long and short rains that will take care of the dry spells for a span of 30 years as recorded after every 10 years i.e. year 1980, 1990 and 2000.

Rainfall data analysis was done parallel to verification of the evolution of the impact of climate change in the area. This was done through assessment of the period before the first storm and time between storms (dry spells). For the period 1980 – 2000, rainfall data indicates climate change evolution that is signified by the changing rainfall and or drought events. This had also an influence on storm / rainfall size from low, average and high, as well as, duration of the dry spells from short, average to long. Since water is an important livelihood asset in The North Nguu Mountains, changing size and pattern of the storms / rainfall and dry spells that results from evolution of climate change is an indication and clear evidence of the impact of climate change on livelihoods in the area. Figure 5.1 presents a schematic outline of rainfall data analysis for year 1980, 1990 and 2000 from the actual rainfall data analysis for Kwediboma village.

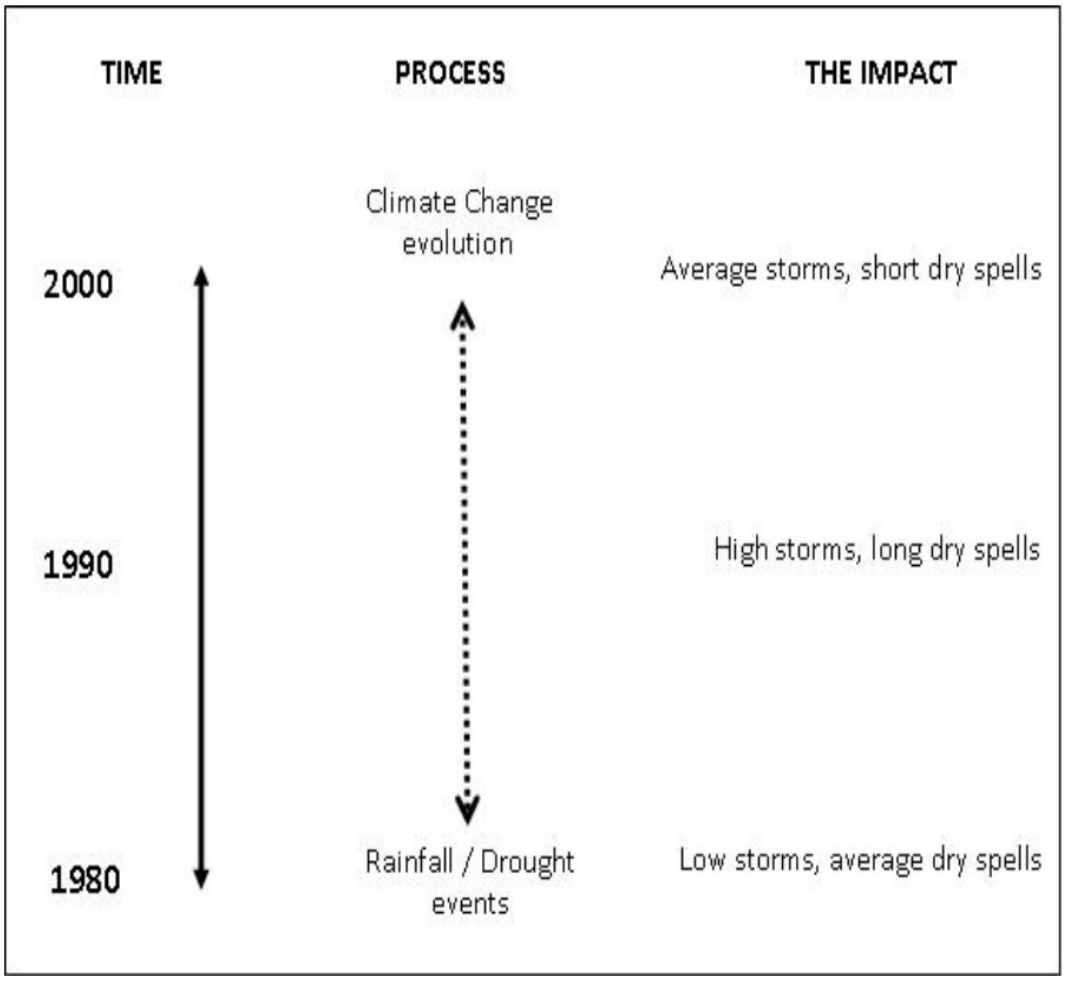

Figure 5. 1: A schematic outline of rainfall data analysis for year 1980, 1990 and 2000 at Kwediboma village

Source: Adopted from Baartman, J.E.M. (2012)

5.4 Findings and Discussions

Rainfall is the main source of water in The North Nguu Mountains whereas water as a livelihood asset is a trigger to livelihoods in the area (KDC, 2000). As observed during discussions with communities when conducting this study, climate change influence rainfall whereas, rainfall through provision of water influence livelihoods in The North Nguu Mountains. The study analyzed rainfall data in terms of

consistency, inconsistency and or a shift of the storm pattern and storm size for all the rain seasons (annual, long and short rains including the dry spells) after every 10 years for a period of 30 years. This was aimed at developing a quick glimpse as evidence of climate change in the area. Table 5.1 presents actual rainfall data for 1980, 1990 and 2000 as recorded at RC Parish Centre in Kwediboma village before being verified, endorsed and supplied to the researcher by The Tanzania Meteorological Agency – TMA.

Table 5. 1: Rainfall records 1980, 1990 and 2000

Year	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
1980	114.8	31.1	97.4	158.1	94.8	0	2.5	28.1	0	0	101.3	77.1
1990	71.2	99.3	268.2	191.2	21.3	12.5	0	0	4.2	10.4	49.5	62.2
2000	50.5	13.0	97.6	m	m	18.8	6.0	12.8	4.3	0	53.4	204.6

Source: TMA (2012), size = mm^3, m – missing

Figure 5.2 presents the actual storm size for 1980 at Kwediboma village.

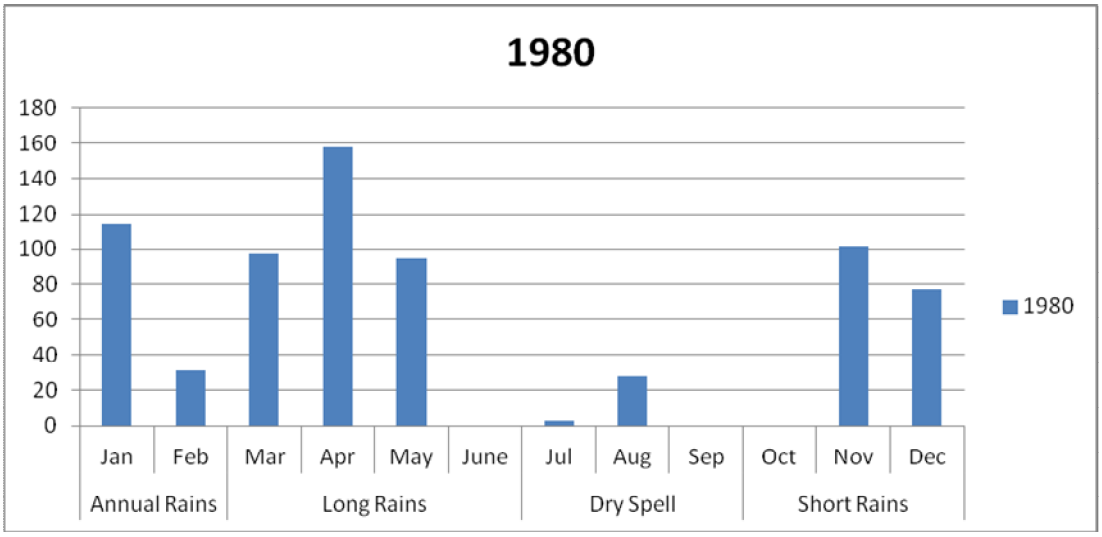

Figure 5. 2: Storm size at Kwediboma village - year 1980 records

Source: TMA (2012), size = mm^3, m – missing

Note that rainfall records for April and May, 2000 are missing. According to the traditional rain seasons in the area, the missing data are of the long rains. Nevertheless, the trend and or results to the analysis is still clear.

Year 1980 experienced higher storms during start of each rain season and the storms kept on decreasing gently in size towards the end of each rainy season. The dry spell was experienced in June but interrupted with a little storm in July and a more notable one in August. The dry spell continued again in September to October. Therefore, generally there was a slight shift of the dry spell and begining of the short rains.

Figure 5.3 indicates storm pattern as recorded at Kwediboma village - 1980.

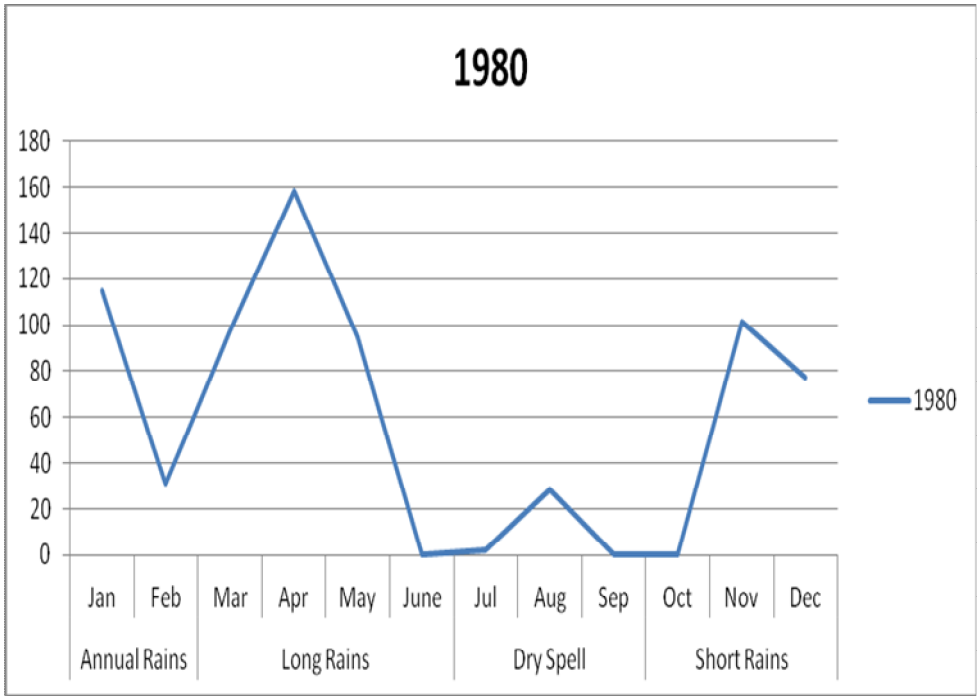

Figure 5. 3: Storm pattern at Kwediboma village - year 1980 records

Source: TMA (2012), size = mm^3, m – missing

Figure 5.4 presents storm size for rainfall as recorded at Kwediboma village (1990)

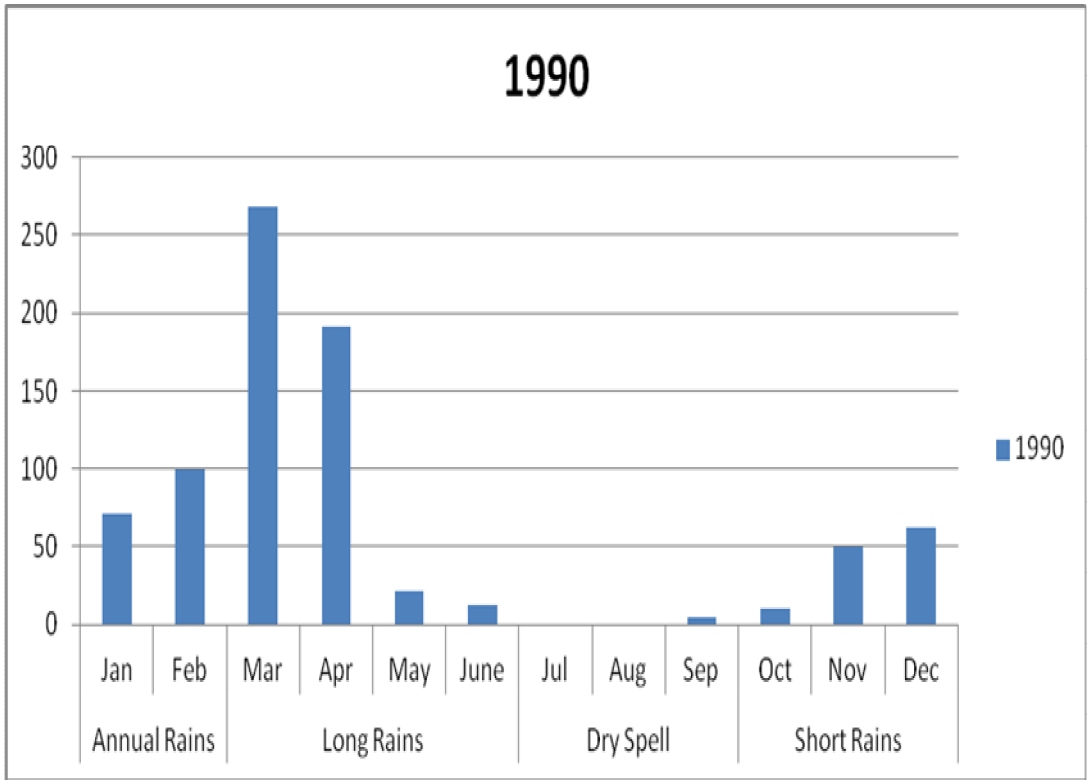

Figure 5. 4: Storm size at Kwediboma village – year 1990 records

Source: TMA (2012), size = mm^3, m – missing

Generally, lower storms were recorded during the start of the annual rains and the short rains. However, it was the reverse with the long rains that started with higher storms (actually the highest storm records in all the rain seasons for the recorded years) falling gently down to the dry spell that started as expected in July - August.

The short rains started earlier in September with low storm size (interrupting the dry spell). There was a slight shift or inconsistency in the short rains that started earlier (September) influencing a shift or cutting short the dry spell as compared to 1980.

Figure 5.5 presents storm pattern as recorded at Kwediboma village in year 1990.

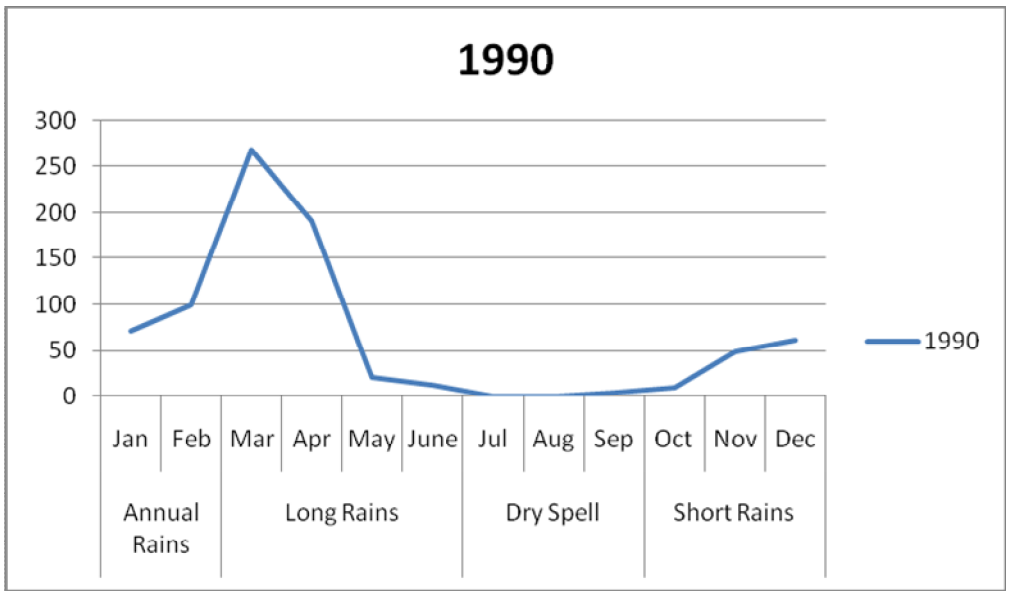

Figure 5. 5: Storm pattern for year 1990 in Kwediboma village

TMA (2012), size = mm^3, m – missing

Figure 5.6 presents the rainfall storm size for year 2000 in Kwediboma village.

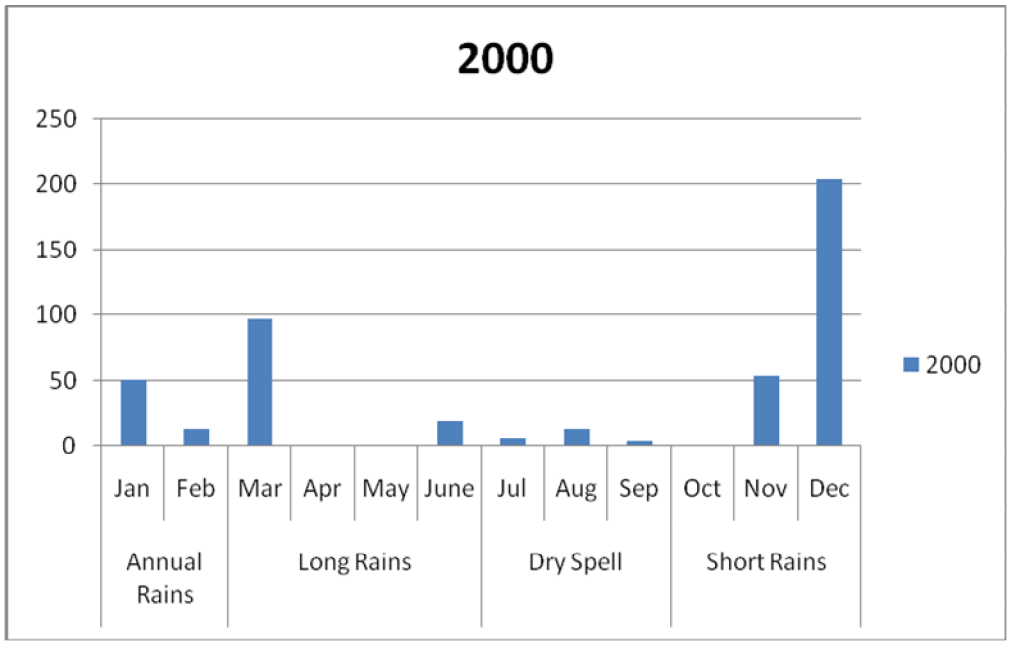

Figure 5. 6: Storm size for Kwediboma village for year 2000.

Source: TMA (2012), size = mm^3, m – missing

This is the year with the missing rainfall records for the long rains (April and May). Generally, year 2000 recorded higher storms in the earlier days of each rain season with the rest of the rain season experiencing moderate to low storms. However, the short rains were experienced late in November with low storms rising gently to the highest storms that were recorded in December.

Therefore, despite the missing records, the long rains started with higher storms during the start of the season in March and extended much longer to the entire period of the dry spell i.e. September. Different from the tradditional notion on the storm patterns, as well as, comparing to the actual rainfall records for 1980 and 1990, the village experienced the dry spell in October leaving again November and December only for the short rains. So generally, there was a shift of the dry spell and the short rains in the year. Figure 5.7 presents the storm pattern at Kwediboma village - 2000.

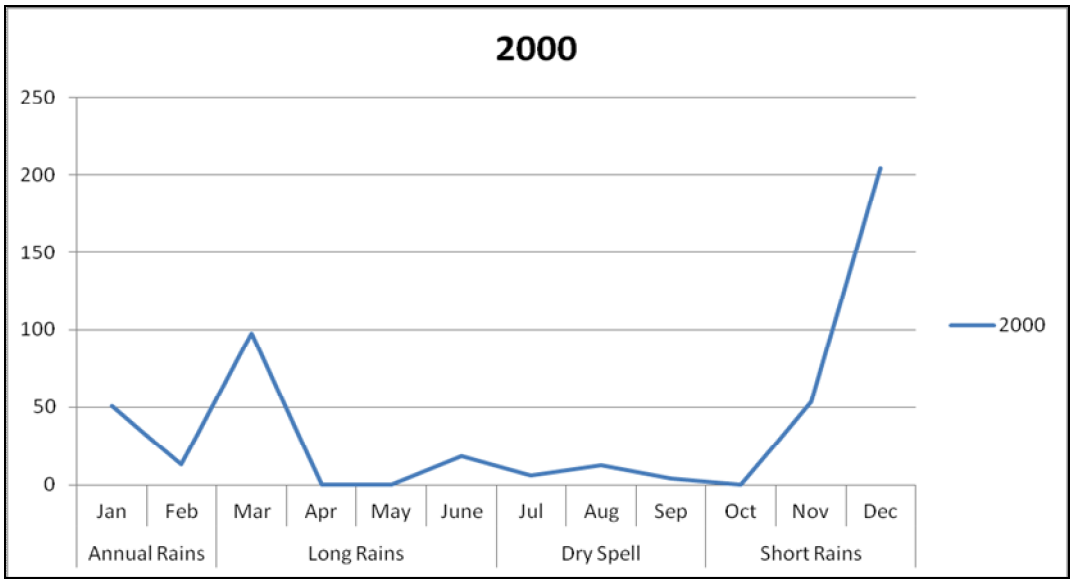

Figure 5. 7: Storm pattern at Kwediboma village in year 2000

Source: TMA (2012), size = mm^3, m – missing

5.5 Rainfall Trend for 1980, 1990 and 2000

Figure 5.8 presents the general analysis of storm perfomance after about every 10 years from 1980 i.e. year 1980, year 1990 and year 2000 in Kwediboma village.

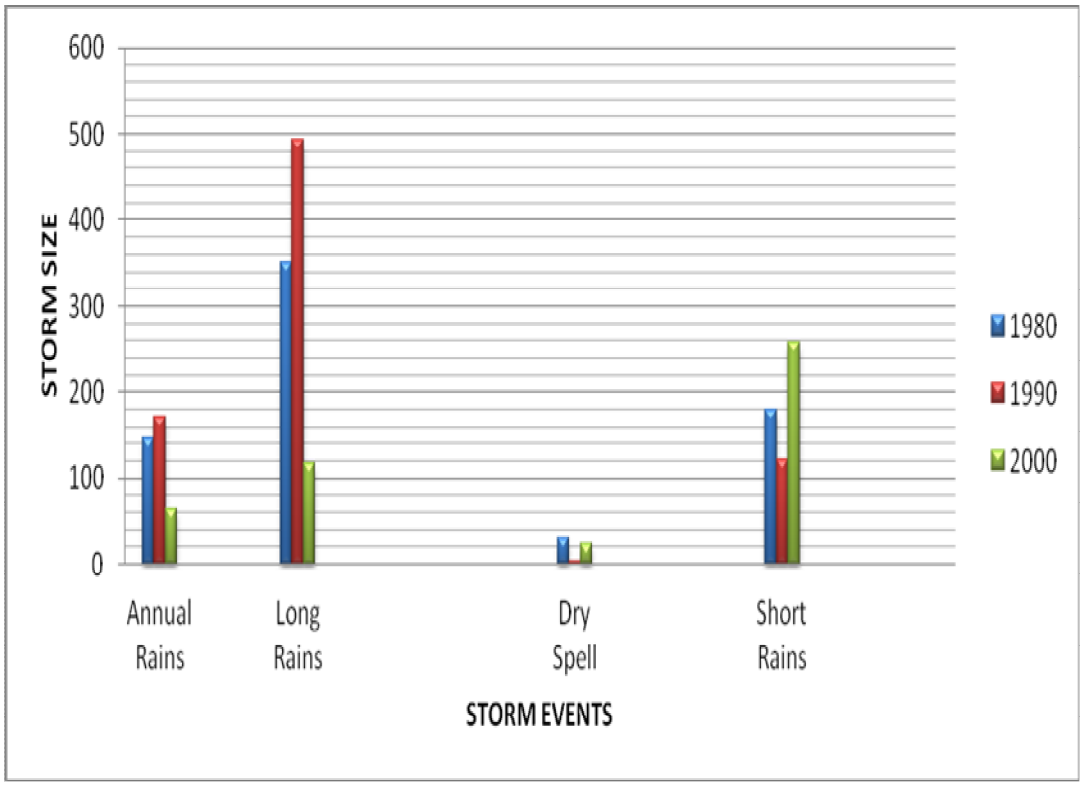

Figure 5. 8: General storm size for year 1980, 1990 and 2000

Source: TMA (2012), size = mm^3

Despite the missing records, the was still more storms during the March – June long rains followed by the mid October – mid December short rains in the village.

The village received less storms further during the January – February annual rains with unexpected little storms during the July – September dry spell. Figure 5.9 presents the general storm pattern for all the rainfall events in the area after about every 10 years from 1980, 1990 and 2000.

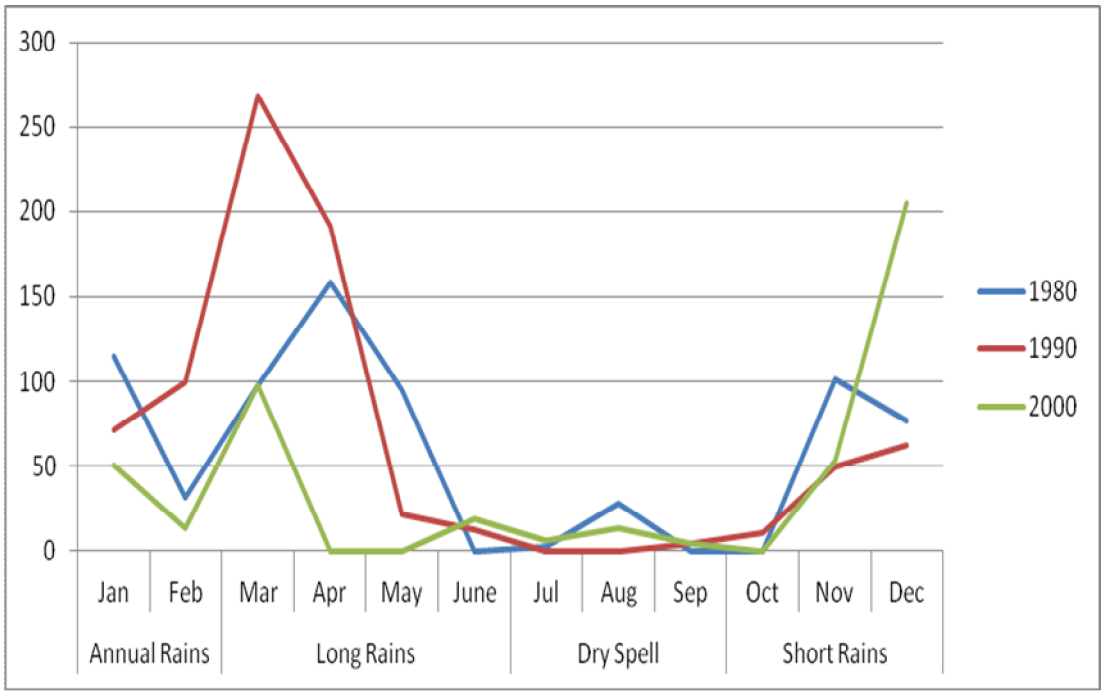

Figure 5. 9: General storm pattern for year 1980, 1990 and 2000

Source: TMA (2012), size = mm^3

Since the short rains of mid-October to mid-December are almost connected to the annual rains (January – February), space between the two rainfall events is not easily visible or notable in arithmetical graphing. However, there is a clear indication of inconsistency and or a shift in storms and storm sizes for all rainfall events in the area. Analysis of storm pattern and storm size for all the rain seasons of the village for the entire study period indicate a remarkable shift on time period and duration, as well as, storm size. Peak of the annual rainfall in the village for 1980, was mid-January (with >120mm^3) whereas, peak of the long rains was in mid-April (with slightly > 150mm^3). The dry spell was experienced in mid-June to mid-October with a storm of about 25mm^3 in August before the short rains started. The short rains came to the peak in mid-November (about 100mm^3).

For year 1990, peak of the annual rains was in mid-January (with about 75mm^3 rising to 150mm^3 towards the end of February) before the long rains started and came to the peak in mid-March (with slightly $\leq$ 275mm^3. The dry spell started in mid-July through September. The area experienced peak of the short rains in mid-November rising to mid-December (slightly with $\leq$ 70mm^3). For year 2000, peak of the annual rainfall was in mid-January (with about 50mm^3), peak of the long rains was in mid-March (100mm^3), the dry spell was in mid-July shortly before it continued from mid-September to mid-October with an interval of about 20mm^3 in August. The area experienced peak of the short rains in mid-December (with $\geq$ 200mm^3). Generally, this trend indicate that there is evidence of inconsistency or a shift of storm events in all the years. For example, peak of the long rains in 1980 was in mid-April but it shifted slowly and was recorded again in mid-March for year 1990.

The rainfall records for April and May year 2000 were missing. However, there is evidence of a high inconsistency in storm size between rainfall events ranging from 50 to 275mm^3 for all the rainfall events for years 1980, 1990 and 2000. Start of the dry spell has shifted from mid-June to mid-October in 1980, 1990 and 2000 with additional light storms in August for years 1980 and 2000. Inconsistency in storm size for the different rainfall seasons is still evident from different storm patterns as recorded in the entire period of the rainfall study. By considering the total storm size for all storm events in years 1980, 1990 and 2000 (i.e. a period of 30 years recorded after every 10 years) it becomes evidently clear that with exception of the missing data for year 2000, storm sizes for the annual, long and short rains differ. This creates uncertainty for the rainfall linked livelihoods. Figure 5.10 (with adjoined

Table 2) presents storm distribution pattern and total storm size for different storm events in 1980, 1990 and 2000 for different storm events for year the same years.

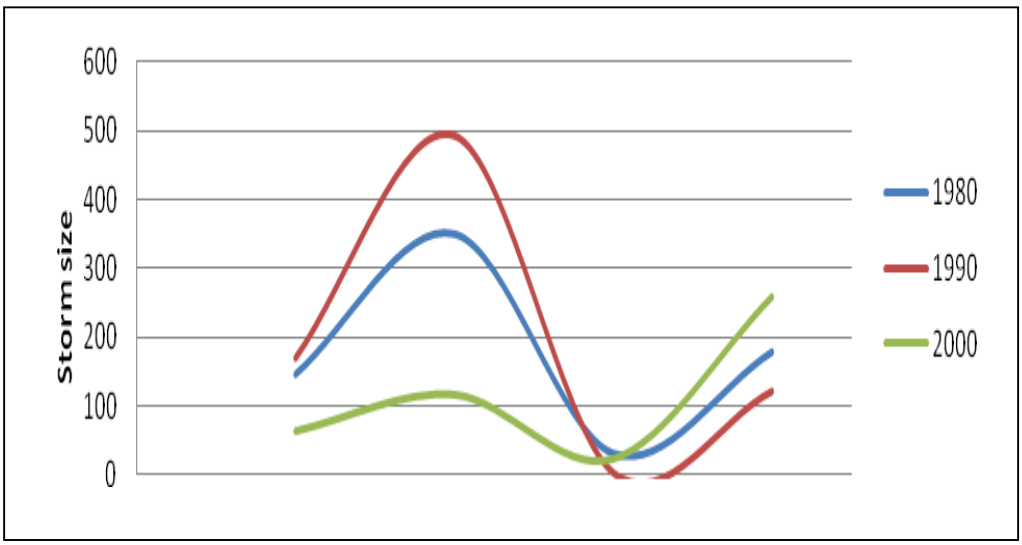

Figure 5. 10: Distribution pattern of storm events 1980, 1990 and 2000; Source: TMA (2012), size = mm^3

Table 5. 2: Rainfall events 1980, 1990 and 2000

	Annual Rains	**Long Rains**	**Dry Spell**	**Short Rains**
1980	145.9	350.3	30.6	178.4
1990	170.5	493.2	4.2	122.1
2000	63.5	116.4	23.1	258

Source: TMA (2012), size = mm^3, m – missing

The general storm pattern from the rainfall data indicate that annual rainfall in all the years i.e. 1980, 1990 and 2000 were below 200mm where it was higher in the 1990‘s close to 200mm and low in 2000 (despite the missing data) but it was below 100mm. The long rains were higher in the records where in the 1990’s it was at 500mm

followed by 1980's where it was 350mm and again lower in 2000 slightly over 100mm. Drought was severe in the 1990's with no storm where the rest of the times storm size was below 50mm. The short rains were high in the 2000's above 250mm and lower in the 1990's slightly over 100mm.

This general trend indicates clearly an inconsistency particularly in storm size over the raining seasons. Rainfall data indicate further that the different storm sizes recorded over the years is influenced by or stimulate a shift in days before the first storm for all the rain seasons in the village. This necessitates a shift of or inconsistency in start and duration of the dry spell in the village. Inconsistency or a shift in the dry spell creates some risks on rainfall triggered livelihoods systems in the area. Extended dry spell is sensitive for crop farmers after planting when plants need moisture and water for flowering. Extension and shifting of dry spells influence also the pastoral systems particularly on pasture and water for livestock.

Normally extended dry spells can lead to serious crop failure, as well as, lack of water and pasture for livestock. This affects also supply of game and non-timber forest products with severe effects on production and productivity of game and the forest resources. Despite some records for the long rains for year 2000 missing, still the average storm sizes are inconsistent throughout the period under study i.e. years 1980, 1990 and 2000. Table 5.3 presents the average storm size for each storm event for 1980, 1990 and 2000 whereas,

Figure 5.10 presents schematic outline of the actual rainfall trend (storm pattern).

Table 5. 3: The average storm size

per storm events 1980 - 2000

Rainfall season / Year	**1980**	**1990**	**2000**
Annual Rains: Jan - Feb	73	85.3	31.8
Long Rains: Mar - June	87.6	123.3	58.2
Dry Spell: Jul - Sept	10.2	1.4	7.7
Short Rains: Oct - Dec	59.5	40.7	86

Source: TMA (2012), size = mm^3, m – missing

Fig. 5.11 presents the average storm size per rainfall event for 1980, 1990 and 2000 as revealed through rainfall data analysis during this study.

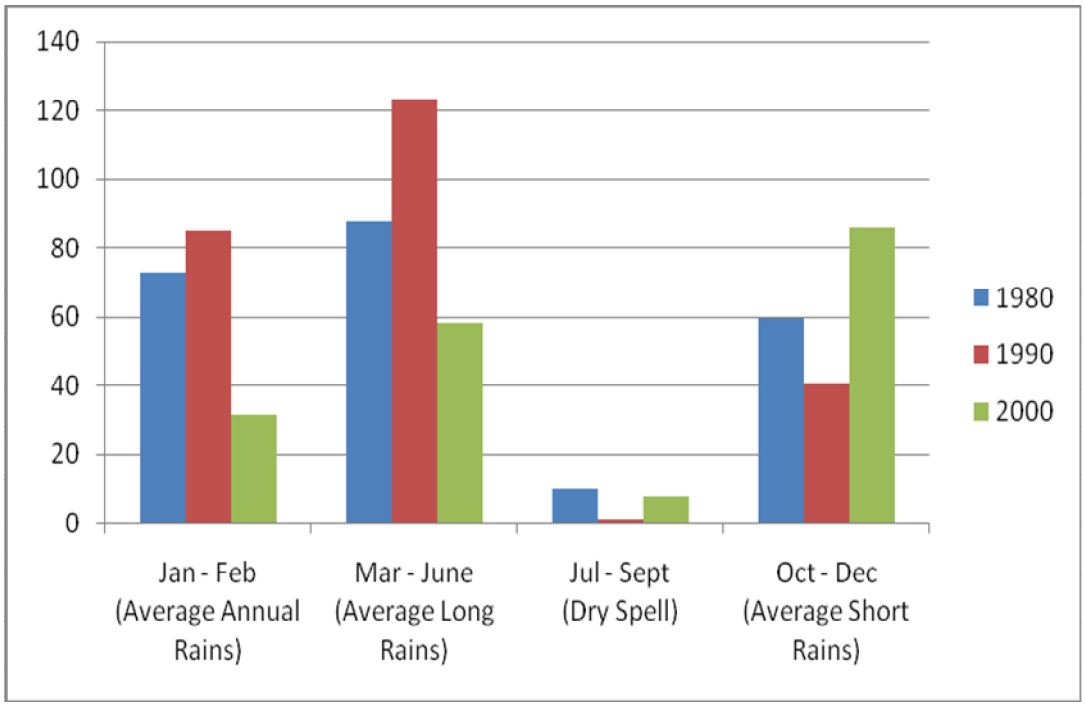

Figure 5. 11: The average storm size per rainfall event for 1980, 1990 and 2000

Source: TMA (2012), size = mm^3, m – missing

Data indicate that there is a great disparity and inconsistency in the average storm size over the period of analysis. For example the average record for the annual rains for year 1980, 1990 and 2000 ranges between 31.8mm^3 (2000) to 85.3mm^3 (1990) whereas, the long rains average is between 58.2mm^3 (2000) to 123.3mm^3 (1990). The short rains average is between 40.7mm^3 (1990) and 86mm^3 (2000) while the dry spell have some storms records with average of 1.4mm^3 (1990) to 10,2mm^3 (1980).

Inconsistency and disparity of the average storm size records for the entire period of 1980 through 2000 is a clear evidence of changing weather conditions due to climate change in the area. Fig. 5.12: presents the average rainfall trends (pattern) per season (storm events) for the recorded period i.e. year 1980, 1990 and 2000.

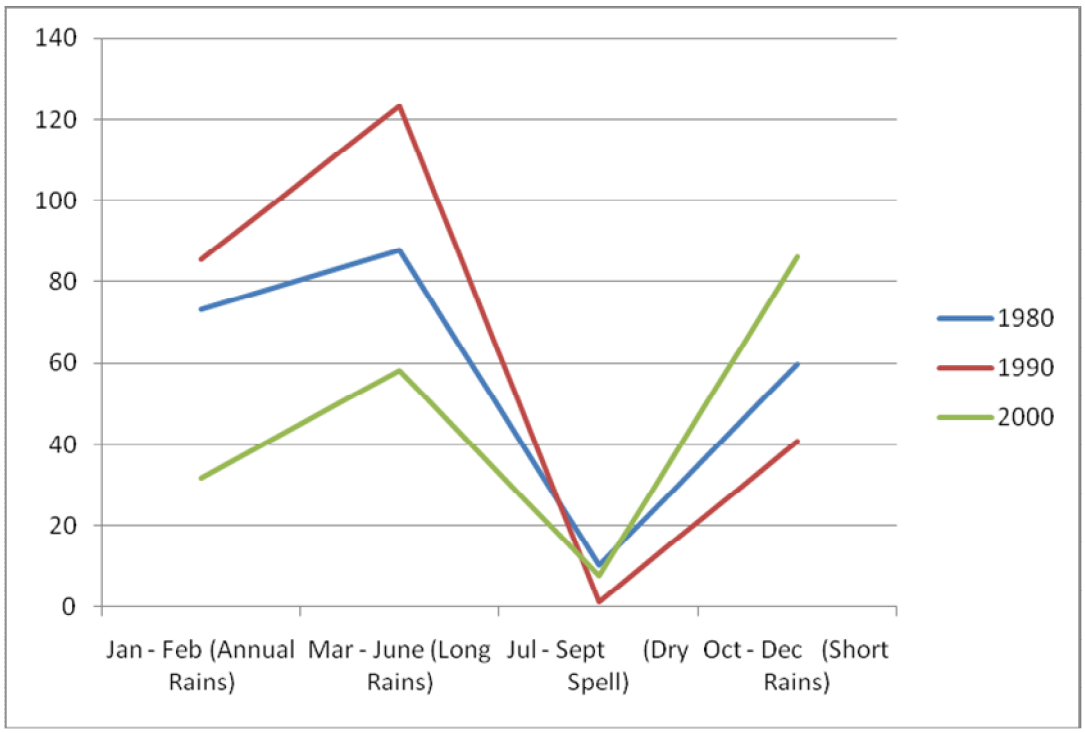

Figure 5. 12: The average storm pattern / storm events 1980, 1990 and 2000

Source: TMA (2012), size = mm^3, m – missing

Despite the missing data for April and May 2000, still there was an increase in the long rains from 1980s and much more in the 1990s with an average of 123.3mm^3 as compared to the short rains in 2000 with an average of 86mm^3 and annual rains with an average of 85.3 mm^3 (1990). The rainfall records during the dry spells were recorded at ≤ 10mm^3. Variation and inconsistency in average rainfall size and trends is an indication for climate change.

5.6 The Average Rainfall and Temperature 1982 - 2012

Kiberashi is a village 4 km north of Gombero village. The climate in Kiberashi is classified as a mild, warm and temperate hot-summer Mediterranean climate with more rainy winter months (Köppen and Geiger, 2010). Kiberashi is the nearest village to Gombero with temperature records. Table 5.4 presents the average annual rainfall and average annual temperature in Kiberashi village for 1982.

Table 5. 4: The average rainfall and temperature in Kiberashi village for 1982

month	1	2	3	4	5	6	7	8	9	10	11	12
mm	97	87	96	128	61	13	10	9	13	27	59	81
°C	21.3	21.5	21.2	20.3	18.6	17.4	16.7	17.1	18.2	19.3	20.6	21.0
°C (min)	15.0	15.1	15.2	15.2	13.7	11.8	10.9	11.0	11.5	12.6	14.1	14.9
°C (max)	27.6	28.0	27.3	25.4	23.6	23.1	22.6	23.3	24.9	26.1	27.1	27.2
°F	70.3	70.7	70.2	68.5	65.5	63.3	62.1	62.8	64.8	66.7	69.1	69.8
°F (min)	59.0	59.2	59.4	59.4	56.7	53.2	51.6	51.8	52.7	54.7	57.4	58.8
°F (max)	81.7	82.4	81.1	77.7	74.5	73.6	72.7	73.9	76.8	79.0	80.8	81.0

Source: Köppen and Geiger (2010)

The average temperatures in Kiberashi village were 20.1 ℃ whereas the average annual rainfalls were 734mm. The difference in rainfall between the driest and wettest months in the village was 119mm. where temperature varied by 4.9 °C for 1982. Figure 5.13 presents the average annual rainfall and average annual temperature - Kiberashi village for 1982.

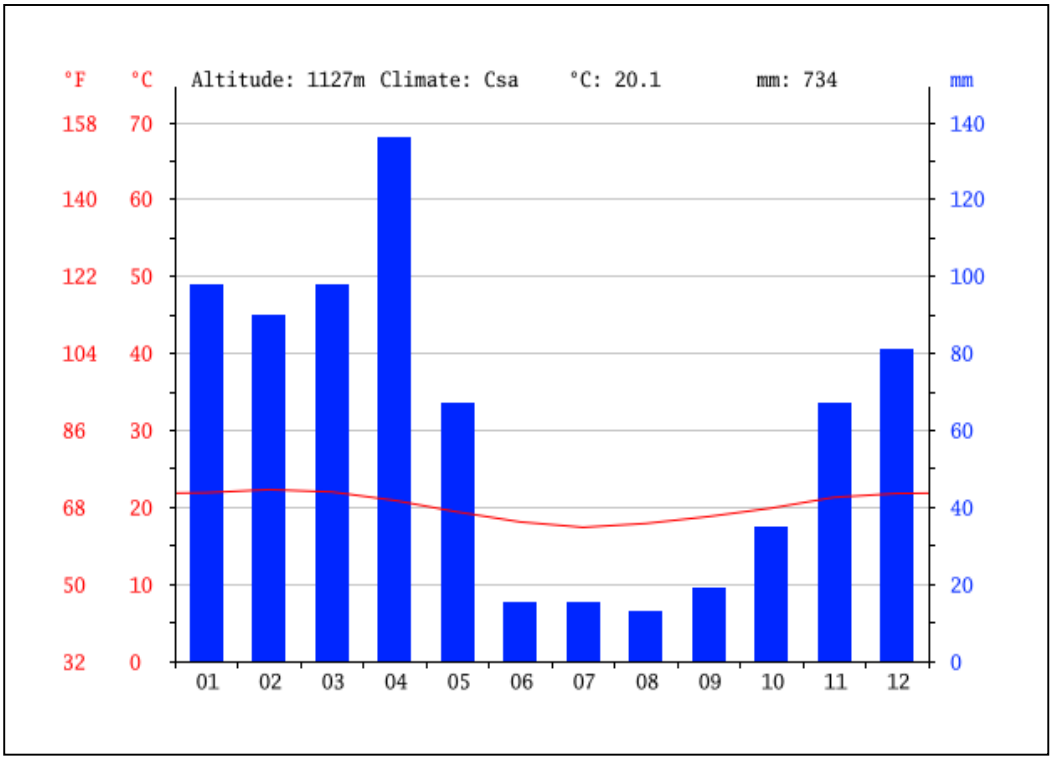

Figure 5. 13: The average annual rainfall and average annual temperature in Kiberashi village for 1982

Source: Köppen and Geiger (2010)

For 1982, the lowest rainfall events with an average of 10 mm were recorded in August whereas, the highest rainfall events with an average of 138 mm were recorded in April. Figure 5.14 presents the average annual rainfall and average annual temperature in Kiberashi village for 1982.

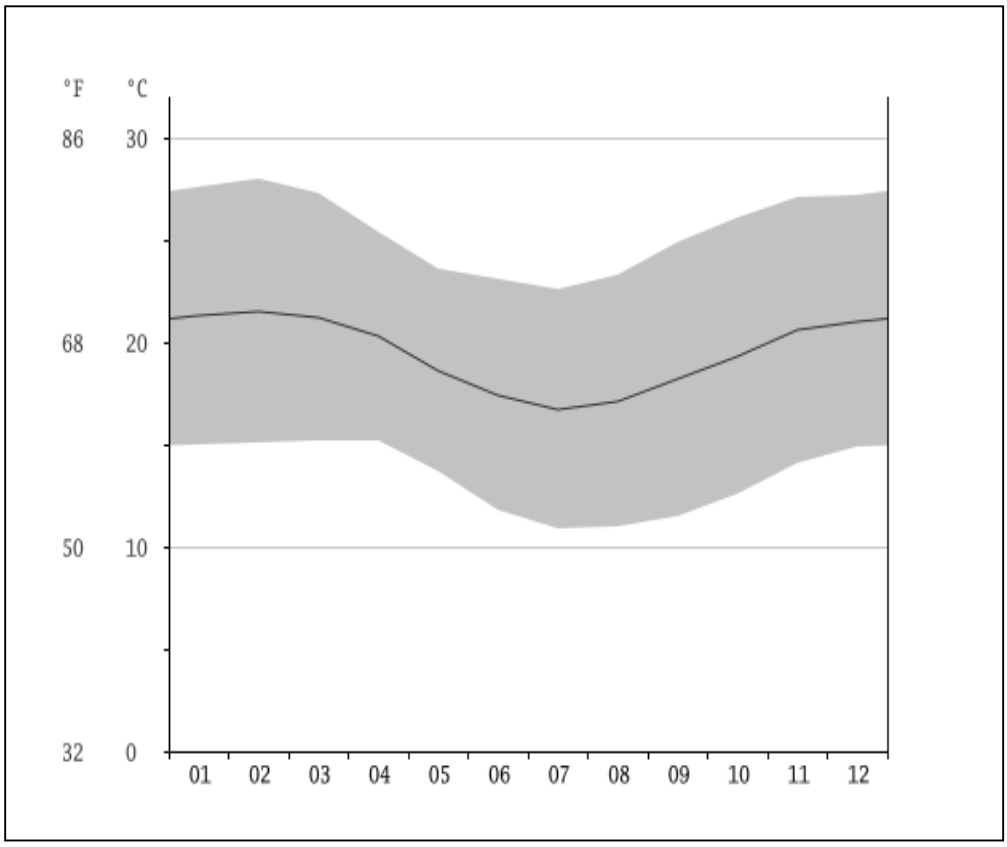

Figure 5. 14: The average annual temperature in Kiberashi village for 1982

Source: Köppen and Geiger (2010)

Generally, therefore, in 1982, the average temperatures in Kiberashi village were higher (about 21.5^0C) in January to March, then November to December. The average temperatures were low (about 17^0C) in the period of June to September. February was the hottest month 28°C where July was the coldest month 10.9 °C.

However, in 2012 (about 30 years later), the average annual rainfall and average annual temperatures for Kiberashi village were recorded again. Table 5.5 presents the average rainfall and temperature for Kiberashi (2012).

Table 5. 5: The average rainfall and temperature in Kiberashi village 2012

month	1	2	3	4	5	6	7	8	9	10	11	12
mm	98	90	98	136	67	15	15	13	19	35	67	81
°C	21.9	22.3	22.0	20.9	19.4	18.1	17.4	17.9	18.8	19.9	21.3	21.8
°C (min)	15.6	15.8	15.9	15.8	14.4	12.4	11.5	11.7	12.1	13.1	14.7	15.6
°C (max)	28.3	28.8	28.1	26.1	24.4	23.9	23.4	24.1	25.6	26.8	27.9	28.0
°F	71.4	72.1	71.6	69.6	66.9	64.6	63.3	64.2	65.8	67.8	70.3	71.2
°F (min)	60.1	60.4	60.6	60.4	57.9	54.3	52.7	53.1	53.8	55.6	58.5	60.1
°F (max)	82.9	83.8	82.6	79.0	75.9	75.0	74.1	75.4	78.1	80.2	82.2	82.4

Source: Köppen and Geiger (2010)

The average temperature in Kiberashi village for the year 2012 was 19.4 °C whereas the average annual rainfall was 681mm. The difference in rainfall between the driest and wettest months in the village was 123mm. where temperature varied by 6.1 °C. Figure 5.15 presents the average annual rainfall and average annual temperature in Kiberashi village for 1982

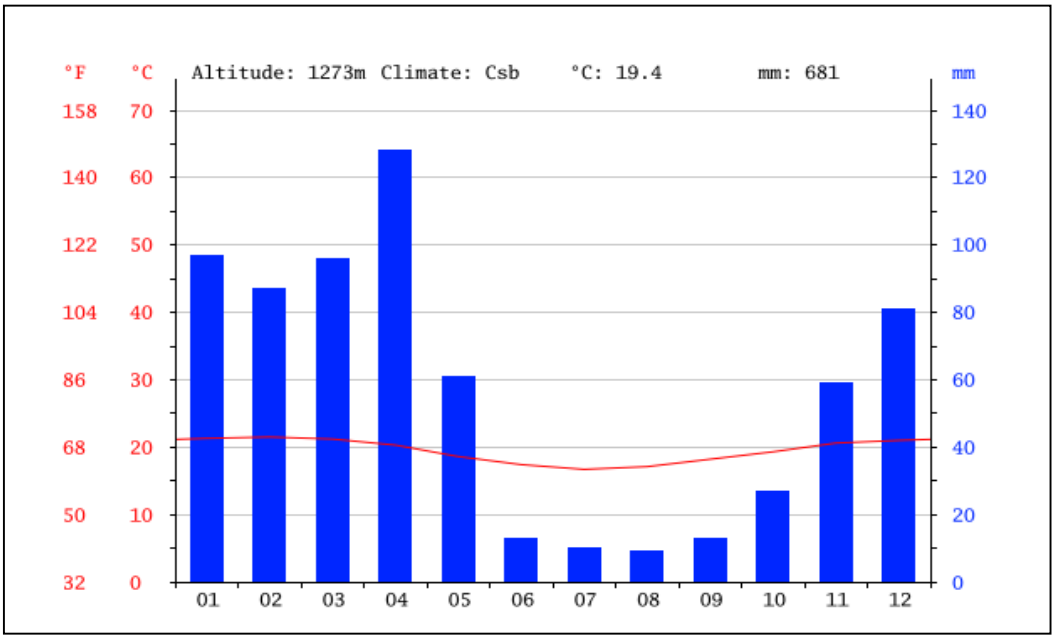

Figure 5. 15: Average rainfall and temperature-Kiberashi 2012

Source: Köppen and Geiger (2010)

For 2012, the lowest rainfall events with an average of 13 mm were recorded in August whereas, the highest rainfall events with an average of 136 mm were recorded in April. Figure 5.16 presents the average annual rainfall and average annual temperature in Kiberashi village for 2012.

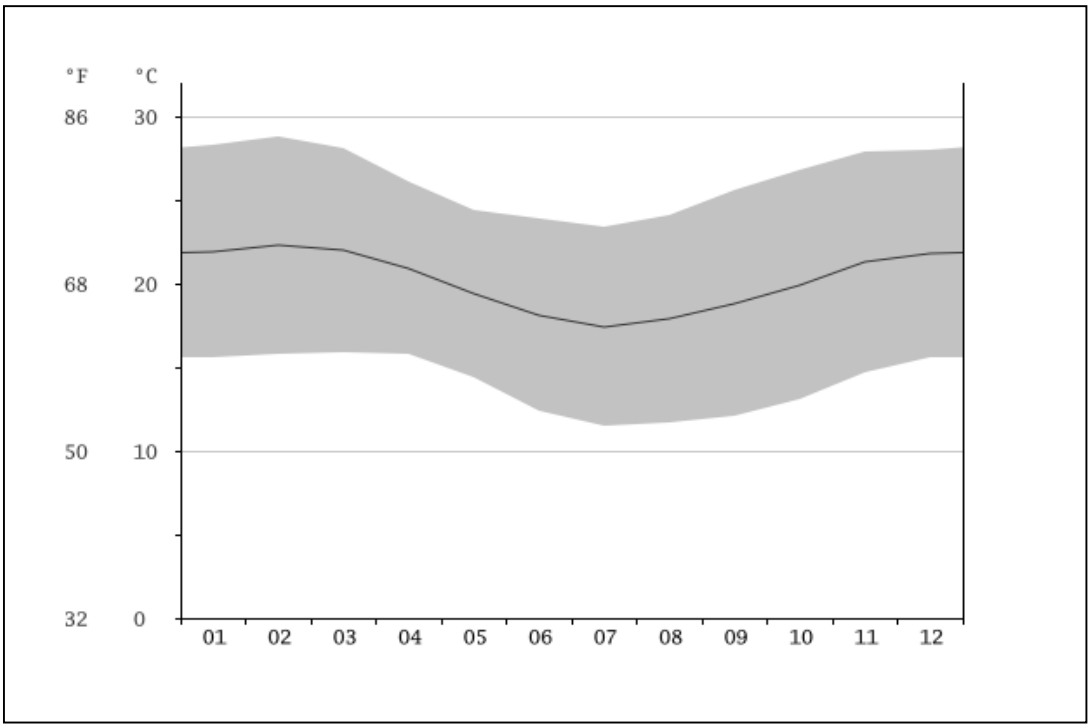

Figure 5. 16: The average annual temperature in Kiberashi village for 2012

Source: Köppen and Geiger (2010)

Therefore, the average temperatures in Kiberashi village were higher (about 20^0C) in January, February and March, then November and December in 2012. The average temperatures were low (about 17^0C) between June and September. February was the hottest month with 28.8 °C where July was the coldest months with 11.5 °C. Table 5.6 Presents summary of rainfall and temperature variation in Kiberashi village for the period 1982 – 2012

Table 5. 6: Summary of rainfall and temperature variation in Kiberashi village for the period 1982 – 2012

	1982	2012	Variability
High rainfall	138 mm	136 mm	-2mm
Low rainfall	10 mm	13 mm	+3mm
Average rainfall	734mm	681mm.	-53mm
High temperature	21.5^0C	22.3 °C	$+0.8^0$C
Low temperature	17^0C	11.5 °C	-5.5^0C
Average temperatures	20.1^0C	19.4 °C	$- 0.7^0$C

Source: Field data (2012)

Generally, volume of the high rainfalls went down by 2mm where the volume of the low rainfalls went up for 3mm. The average rainfalls went further down by 53mm most likely on low volumes of rainfall or reduced span of the rainfall events. Also, the temperature went higher by 0.8^0C during the high temperature periods and it went down by 5.5^0C during the low temperature seasons. The average temperature in the village went down slightly by 0.7^0C during the period 1982 – 2012.

Tamota is another village located in the valley bottoms connecting Kilindi, Lulago and Kwediboma villages. According to Köppen and Geiger (2011), the weather conditions and thus climate in Tamota village is classified as tropical savanna climate where summers are rainier than the winters and this buffers also Kilindi, Kwediboma and Lulago villages. Generally, Tamota village is the nearest village to Kilindi, Kwediboma and Lulago i.e. study villages with rainfall and temperature

records that covers the study period. Table 5.7 presents the average annual rainfall and average annual temperature for Tamota village 1982.

Table 5. 7: The average rainfall and temperature for Tamota village 1982

month	1	2	3	4	5	6	7	8	9	10	11	12
mm	122	110	125	144	97	20	25	15	35	60	93	103
°C	23.8	24.0	23.8	22.7	21.2	20.1	19.3	19.8	20.7	21.8	23.0	23.7
°C (min)	17.4	17.6	17.6	17.6	16.2	14.3	13.3	13.5	13.9	14.9	16.4	17.4
°C (max)	30.2	30.4	30.0	27.9	26.3	25.9	25.3	26.1	27.5	28.7	29.7	30.0
°F	74.8	75.2	74.8	72.9	70.2	68.2	66.7	67.6	69.3	71.2	73.4	74.7
°F (min)	63.3	63.7	63.7	63.7	61.2	57.7	55.9	56.3	57.0	58.8	61.5	63.3
°F (max)	86.4	86.7	86.0	82.2	79.3	78.6	77.5	79.0	81.5	83.7	85.5	86.0

Source: Köppen and Geiger (2010)

The average annual temperature for Tamota village was 22.0 °C where the village received about 949 mm of rainfall annually in 1982. The difference in rainfall between the driest and wettest months was 129 mm. where variation in temperatures was 4.7 °C throughout the year. Figure 5.17 presents the average annual rainfall and average annual temperature in Tamota village for 1982.

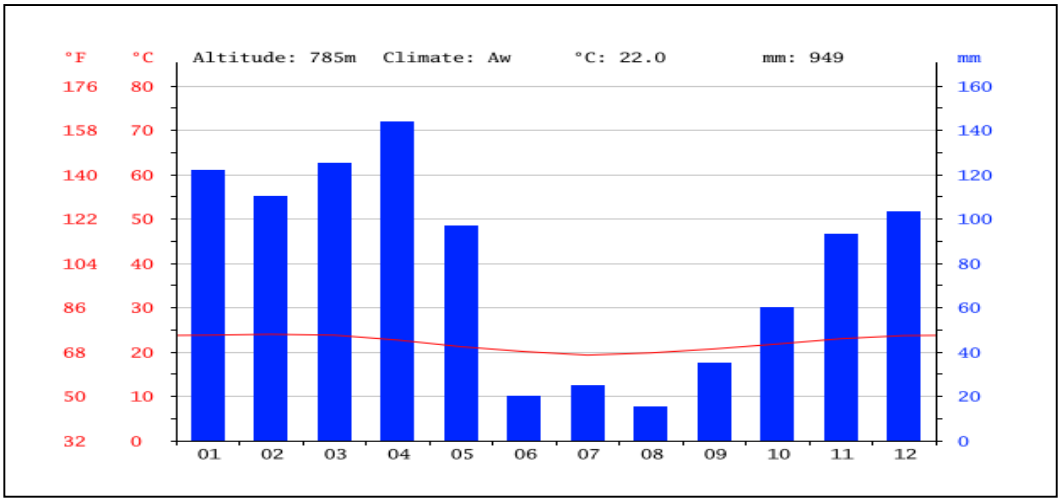

Figure 5. 17: Average rainfall and temperature in Tamota village for 1982

Source: Köppen and Geiger (2010)

Figure 5.18 presents the average annual rainfall and average annual temperature in Tamota village for 1982.

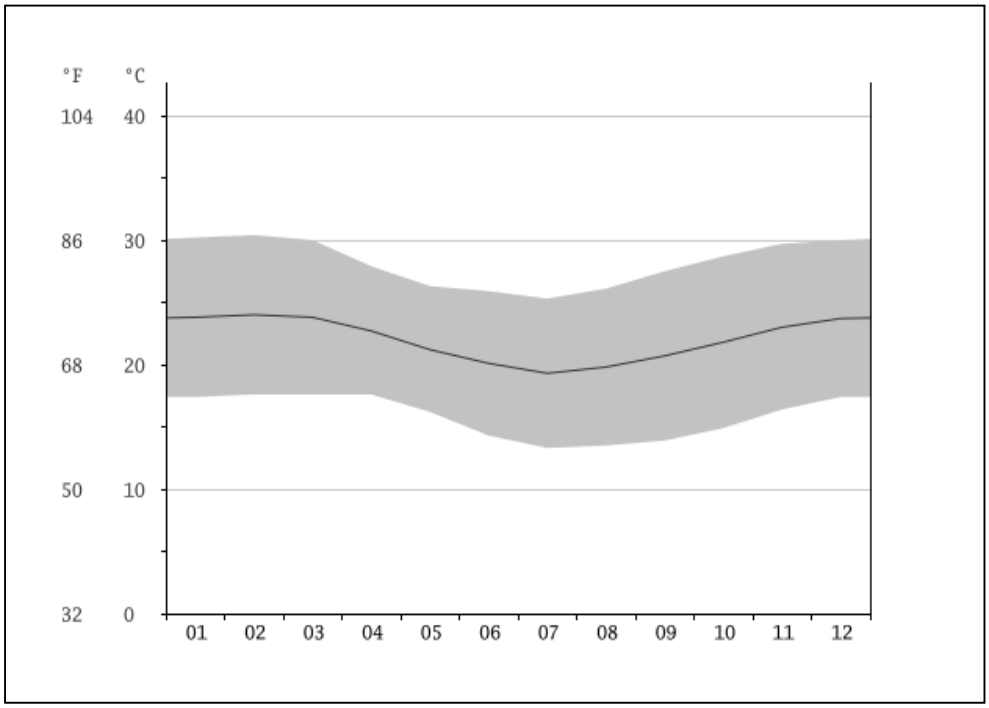

Figure 5. 18: The average annual temperature in Tamota village 1982

Source: Köppen and Geiger (2010)

Rainfall events in Tamota village were much lower in August 1982 recording an average of 15 mm. where the highest rainfall events occurred in April with an average of 144 mm. Generally, Average temperatures were higher about 25^0C in January – March, November – December. The average temperatures were low (about 20^0C) between June and August, 1982. Therefore, in 1982, Tamota village recorded higher average temperatures (about 21.5^0C) in January to March, then November to December. The average temperatures were low (about 17^0C) in the period of June to September. February was the hottest month with 30.4°C while July was the coldest months with an average of 13.3 °C. Likewise, in 2012 (about 30 years later), the

average annual rainfall and average annual temperatures for Tamota village were recorded as presented in Table 5.8

Table 5. 8: The average rainfall and temperature in Tamota village for 2012

month	1	2	3	4	5	6	7	8	9	10	11	12
mm	77	67	167	341	324	113	98	98	108	167	178	139
°C	22.7	23.0	22.7	21.6	20.2	19.1	18.1	18.0	18.6	19.8	21.4	22.2
°C (min)	17.6	17.5	17.7	17.8	16.9	15.4	14.5	14.2	14.4	15.3	16.7	17.3
°C (max)	27.8	28.5	27.8	25.4	23.6	22.8	21.8	21.9	22.9	24.3	26.1	27.1
°F	72.9	73.4	72.9	70.9	68.4	66.4	64.6	64.4	65.5	67.6	70.5	72.0
°F (min)	63.7	63.5	63.9	64.0	62.4	59.7	58.1	57.6	57.9	59.5	62.1	63.1
°F (max)	82.0	83.3	82.0	77.7	74.5	73.0	71.2	71.4	73.2	75.7	79.0	80.8

Source: Köppen and Geiger (2010)

The average temperature in Tamota village for the year 2012 was 20.6 °C whereas the average annual rainfall was 1,877mm. Figure 5.19 presents the average annual rainfall and average annual temperature in Tamota village for 2012.

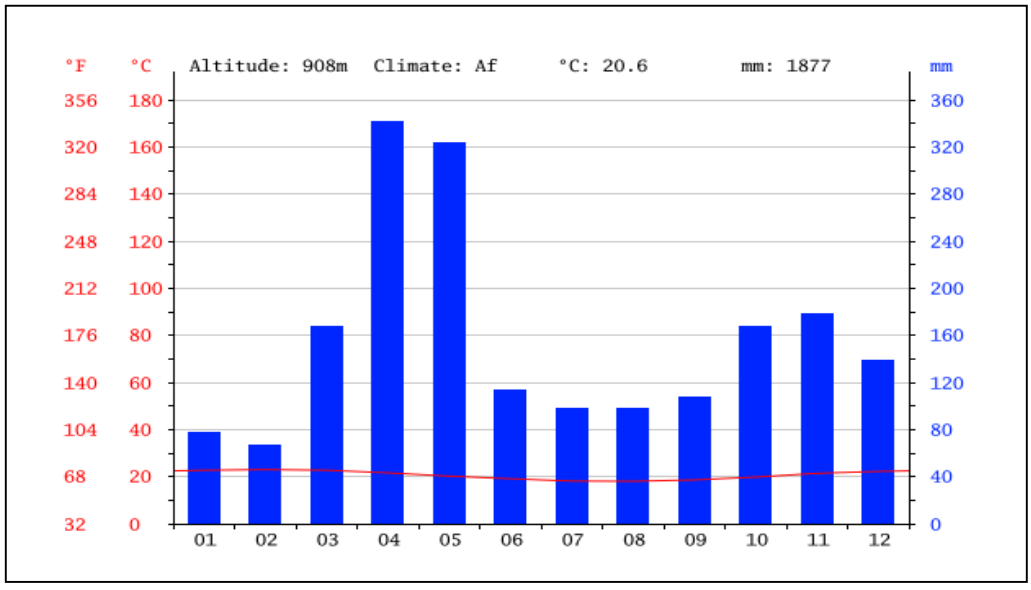

Figure 5. 19: The average annual rainfall and temperature Tamota village 2012

Source: Köppen and Geiger (2010)

The difference in rainfall between the driest and wettest months in Tamota village was 274mm. where temperature varied by 14.3 °C. For 2012, the lowest rainfall events with an average of 67 mm were recorded in February whereas, the highest rainfall events with an average of 341 mm were recorded in April. Figure 5.20 presents the average annual rainfall and temperature in Tamota village for 2012.

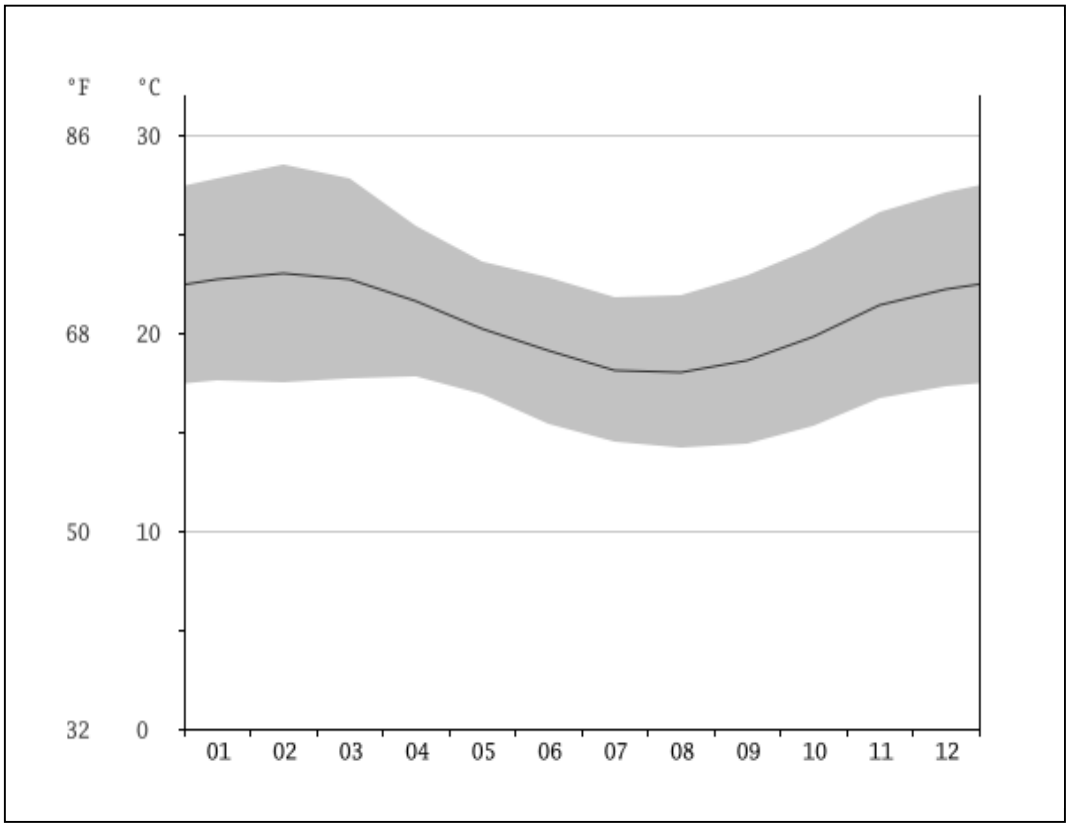

Figure 5. 20: The average annual rainfall and temperature Tamota village 2012
Source: Köppen and Geiger (2010)

Therefore, the average temperatures in Tamota village were higher (about 24^0C) in January, February and March, then November and December in 2012. The average temperatures were low (about 18^0C) between June and September. February was the hottest month with 28.5 °C where August was the coldest months with 14.2 °C.

Generally, volume of the high rainfall events in Tamota went high by 197mm and the volume of the low rainfall events went up for 52mm. The average rainfalls went up further by 928mm most likely on high volumes of rainfall or increased time for rainfall events. However, temperature records in Tamota village went high by 3.5^0C during the high temperature periods but it went down by 5.8^0C during the low temperature seasons. The average temperature in the village went down slightly by 1.4^0C during the period 1982 – 2012. Table 5.9 Presents summary of rainfall and temperature variation in Kiberashi village for the period 1982 – 2012

Table 5. 9: Summary of rainfall and temperature variation in Tamota village for the period 1982 – 2012

	1982	**2012**	**Variation**
High rainfall	144 mm.	341 mm	+197mm
Low rainfall	15 mm.	67 mm	+52mm
Average rainfall	949 mm	1,877mm.	+928mm
High temperature	25^0C	28.5 °C	$+3.5^0$C
Low temperature	20^0C	14.2 °C	-5.8^0C
Average temperatures	22.0 °C	20.6 °C	-1.4^0C

Source: Field data (2012)

Generally therefore, meteorological data particularly on rainfall is a useful and an important component in any livelihood study. However, there are serious data management and generalizations that sometimes mislead the process of knowledge building. For example, Kilindi district in which The North Nguu Mountains is located is reported to be having a 'bi-model' rainfall pattern (KDC, 2000). Through

discussions with local communities on rainfall distribution patterns and through analysis of actual data records this study revealed existence of three storm events in the area that include the annual rains expected between mid-January and mid-February, the long rains from mid-March to mid-June and the short rains from mid-October to mid-December.

This study has revealed a close link between climate change, rainfall patterns and rainfall size in the North Nguu Mountains. It revealed further that livelihoods in The North Nguu Mountains depend primarily on water availability and rainfall is the major and primary water source in the area. Changing rainfall (storm events and storm size) have impact on livelihoods in the area. Higher rainfall (storm sizes) lead to flooding whereas low rainfall leads to dry spell events (drought) both of which have impact on livelihoods in the area. Rainfall data analysis shows a big variation in storm size for the storm events for years 1980, 1990 and 2000. For example, despite of the missing long rains records for April and May 2000, there is still a high variation in the monthly totals for years 1980, 1990 and 2000 ranging from a nil record for June 1980 to $268mm^3$ for March 1990.

This study revealed also that the changing rainfall trends and rainfall size have some effects on the forest. It affects production and productivity of the forest ecosystem thus availability of goods and services from the forest ecosystem. Moreover, there is also enough evidence of increased risks for crop failures for farmers, as well as, shortage of pasture and water for the nomadic agro-pastoral systems including those who go for hunting and collection of the non-timber forest products for making part

of their living in the area. Analysis of the spatial scale rainfall data indicates a clear evidence of climate change influencing water availability that extend to livelihoods in the area. Generally, this study verify and give a clear evidence of climate change evolution (through rainfall and temperature) in the area.

5.7 Summary

This study revealed that rainfall is the only reliable water source and furthermore, water was established to be among the fundamental assets for livelihoods in the area. Analysis of actual rainfall pattern signify climate change processes. Generally, this study indicate that, there was a shift in storm pattern and variation in rainfall (storm size) in the study area within the study period. Storm size (rainfall) was generally moderate in the 1980's whereas it was very high in the 1990's and became very low in the 2000's. Generally, the storm (rainfall) trend and size indicate a great variation in timing and size which determines water availability for livelihoods for The North Nguu Mountains. The frequent variation on storm (rainfall) shift (trend) and storm (rainfall) size (volume) over a period of time that impacts also growth and nutrition wealth of the forest thus affecting provision of goods and services from the forest ecosystem as revealed through this study remains to be the main root factors and causing agents for the impact of climate change on livelihoods in the area.

CHAPTER SIX
6.0 THE IMPACT OF CLIMATE CHANGE ON RURAL LIVELIHOODS

6.1 Introduction

This chapter presents the results with discussions on the impact of climate change on the livelihoods in The North Nguu Mountains. Information in this chapter is presented in two sections: Section one is on the common livelihood strategies in The North Nguu Mountains i.e. the way that people (communities) make their living (the livelihood strategies) in the area. Information from this section lays the baseline for the assessment of the impact of climate change on livelihoods. The second section presents the impact of climate change on the livelihood systems and the resulting social economic and environmental impacts on people's daily living in the area i.e. the impact of climate change on livelihoods in the area as set out in the main tittle and the second objective of this study.

6.2 Livelihood Strategies in The North Nguu Mountains

Information from communities indicates that the common livelihood strategies in The North Nguu Mountains include crop farming, livestock keeping under agro-pastoral systems, trading that include petty business, collection of non-timber forest products, hunting and collection of specific bits and pieces from game, as well as, performing traditional practices on preventive and curative services for the human and livestock. These were revealed to be the main livelihood strategies in the area. It should be noted that although small scale mining prosperity was rampant in Kilindi

district, the mining prospectors in The North Nguu Mountains were operating individually in very low scales and poor conditions. Most of the local communities were getting into mining activities as a temporary employment or as labourers during exploration visits. During discussions, some community members connected mining activities to hunting and some to petty business clusters. Others connected it to collection from the forest. Table 6.1 presents the common livelihood strategies in The North Nguu Mountains. 7

Table 6. 1: The common livelihood strategies in The North Nguu Mountains

No.	**Livelihood strategies**	**No.**	**%**
1.	Crop farming	393	32.0
2.	Livestock keeping under agro-pastoralism	293	23.9
3.	Petty business	207	16.9
4.	Collection from the forest	238	19.4
5.	Hunting and mining prosperity	83	6.8
6.	Ritual services	11	1.0
Total		1,225	100.0

Source: Field Data (2012)

About 98% of the respondents responded to the question that required them to the common livelihood strategies in The North Nguu Mountains from communities during this study were as follows:

6.2.1 Crop farming

As indicated in Table 6.1, a total of 32% of respondents showed that they make their living by crop farming. Generally, crop farming was revealed to be the common livelihood strategy that supports most individuals, families and households in the

area. It was revealed further during discussions that most of the immigrants in the villages were engaged in crop farming. Crop farming provides food trading goods. Such products include cereals, fruits and vegetables that are also used as food crops. Information indicate further that crop farming employs individuals, families and households in the area. Text box 6.1 presents information from a key informant on crop production in Kilindi village.

> ‘ ... there is nothing I can do here for my day to day survival except tilling the land for crop farming ... I’ve been doing crop farming when I was still with my parents ... now I’m doing it with my family for food and for income also ... my friends and my relatives are doing it for food and for income too ... crop farming is in general our living here in this village ... ’ (A farmer: Kilindi village, 2011)

Text Box 6. 1: Crop production for living in Kilindi village

Source: Field Data (2012)

Figure 6.1 and 6.2 present crop farming in The North Nguu Mountains.

Figure 6. 1: Traditional irrigated crop farming in Lulago village
Source: Field Data (2012)

Figure 6. 2: Rain fed maize fields in Kilindi village

Source: Field Data (2012)

Generally, information from this study ranks crop farming to be the major livelihood strategy and the economy base in The North Nguu Mountains. However, field observations show that people are mostly practicing rain fed crop farming with small scattered crop fields under supplementary traditional irrigation practices and systems located mainly on mountain slopes and some towards the valley bottoms in the lowlands underneath the forest top mountains.

6.2.2 Livestock keeping

A number equivalent to 23.9% of all respondents to the questionnaire interview (Table 6.1) who responded to the question that was seeking information on how they make their living informed that they make their living out of livestock keeping.

Similar to the findings from questionnaire interview, information from focus group discussions in all the study villages, together with data from in-depth interviews with key informants in all villages mentioned livestock keeping to be among the common livelihood strategies. All focus group discussion members from all the study villages for example observed and agreed together that livestock keeping (for both those with permanent settlements in the villages and also for the pastoral communities who stay in the villages for some times only) to be an eminent strategy that support most families and households for food and income.

The findings from key informants indicate further that apart from the natives i.e. people who have been residing in the area since before the 1970's villagization process in the country, most of the new comers in the villages are livestock keepers mostly engaging in the nomadic agro-pastoral systems. Information indicates further that livestock keeping provides food and income to the livestock keepers but it provides also products for trading such as beef, milk and other livestock products.

The key informers indicated further that the cattle keepers, the ones who herd cattle and those engaged in trading cattle products generate income from cattle to support their living. More information from focus group discussions from all the study villages indicate further that livestock keeping employs much of the individual, family and household labour force in the area.

The Village Secretary for Gombero village for example declared during discussions that the village hosts an average of 5 to 10 agro-pastoral groups and or families that

come into the village looking for settlements with their cattle herds each year. Text box 6.2 presents information from a livestock keeper from Gombero village.

> ‘ ... I normally keep more land for grazing near my settlement than the portion of land that I keep for crop farming ... you know, even when at home, cattle need more space to relax ... this is more important for me than the space for crop farming ... I’ve to ensure space is available because it’s cattle that makes us as a family to continue surviving in this village ... ’ (A farmer: Gombero village, 2011)

Text Box 6. 2: Livestock keeping and crop farming in Gombero village

Source: Field Data (2012)

Figure 6.3 and 6.4 present the common livelihood strategies and the economy base in The North Nguu Mountains.

Figure 6. 3: Grazing - Gombero village

Source: Field Data (2012)

Figure 6. 4: Grazing - Kilindi village

Source: Field Data (2012)

When in informal discussions during this study, the village secretary for Gombero village insisted the village government to have more pressure on livelihood issues from the livestock keepers (from within and outside the village) compared to people from the other livelihood strategies. Text box 6.3 presents a note on the agro-pastoral communities entering Gombero village.

> ‘ ... livestock keepers (mainly the agro-pastorals) from distant places keep coming in the village when it gets dry where they come from ... they normally move back to their homes again when the situation improves. Likewise, livestock keepers from within the area keep moving out for some times when there are no enough grazing lands and water for livestock ... I think livestock keeping supports the living of most people within and outside this village ... ‘ (Local leader: Gombero village, 2011)

Text Box 6. 3: Livestock keepers in Gombero village

Source: Field Data (2012)

6.2.3 Collection of the non-timber forest products

A total of 19.4% of all respondents (Table 6.1) showed that they make their living mostly on the collection of specific bits and pieces from game and the non-timber forest products mainly for food and trading. This was clarified more during discussions and in-depth interview with key informants that despite being engaged in crop farming, livestock keeping or trading and other means for their living, they engage in collection of the non-timber forest products including also specific bits and pieces from game for their living.

Further information from discussions including in-depth interviews with key informants in Kilindi and Lulago villages, for example, supported collection of specific bits and pieces from game and the non-timber forest products to be a common strategy for some people who are living in the area adjacent to the forests. Generally, the process of collecting specific bits and pieces from game and the non-timber forest products by communities as a livelihood strategy was ranked lower than crop farming, livestock keeping and trading but was referred to as a highly reliable strategy for supporting individuals, families and households for food and income directly and through trading.

Further findings from key informants indicate that apart from the natives i.e. people who were in the area before the country's villagization programme in the 1970's, most of the new comers and in-migrants are coming in the area for collection of specific bits and pieces from game and the non-timber forest products for both consumption and trading. The key informants reveal further that before the

villagization process, collection from the forest was very common. It went a little bit down during and after the country's villagization process but it is now picking up vigorously again as people have already settled, got used to the situation of living from collecting in the forest i.e. know exactly what is available where inside the forest including where is the market and what is the market price.

Information indicated further that those who are coming in the area for game and the non-timber forest products are mostly linked to the petty trading business community. Information indicated further that those who collect from the forest are always linked to traders in a form of a value addition chain to the collected forest products. Value adding is done mostly by processing the wood and non-wood products for handcrafts and or medicinal use values that fetches more income in the market. Information indicate further that the collection of specific bits and pieces from game and the non-timber forest products employed manpower (the human labour force) particularly from individuals, families and households those who their main living depend on collections from the forest. Text box 6.4 presents information on the forest potential in Kilindi village

> ' ... I'm keeping a family of five ... my wife is busy buying and selling in the daily and weekly markets within and in nearby villages ... I mainly make handcrafts such as mats, baskets ... wooden handles for axes and hand hoes including some decorations for our own use and I give the extra to my wife for selling ... the products earn us some income ... I remember to have used the income to pay for medical bills when we got our first daughter ... and again when registering her in school ... collection from the forest is the backbone for our living in this village ... ' (Farmer: Kilindi village, 2011)

Text Box 6. 4: Potential of the forest in Kilindi village

Source: Field Data (2012)

The key informer revealed further that getting hold and use of game meat or any other game product requires a permit from the government particularly the natural resources licensing authorities mainly at district level and above. However, given the collaborative forest and game management frameworks, communities in the area consider collection of specific bits and pieces from game for consumption to be normal and unrestricted. Even though, still communities handled such practices cautiously and in privacy.

Figure 6.5 and 6.6 present trading of game and some handicrafts made from the non-timber forest products to support and the economy for some individuals, families and households in The North Nguu Mountains.

Figure 6. 5: Open market for game meat in Kilindi village

Source: Field Data (2012)

Figure 6. 6: Women in Gombero village making mats and baskets

Source: Field Data (2012)

6.2.4 Petty trading

A total of 16.9% of all respondents (Table 6.1) make their living by engaging in petty trading. Further information from discussions including information from in-depth interviews with key informants from all the villages indicates that petty trading has for quite long time being a common strategy for people to make their living and also a means to accumulate wealth from both the people and the forest resource in the area. Generally, the findings indicate further that petty trading scored lower than crop farming and livestock keeping but slightly higher than the collection of specific bits and pieces from game and the non-timber forest products for supporting the daily living processes in the area. It is further revealed during discussions that petty trading

creates employment opportunities to individuals, families and households providing purchasing power for food and other livelihood expenditures including provision of income security for people in the area.

Information from key informants indicate further that apart from the people who have stayed longer i.e. before the 1970's villagization process in the area, most of the in migrants in the area are people who are mostly coming in specifically for engaging in buying and selling of farm crops, livestock and livestock products including specific bits and pieces from game and the non-timber forest products for petty trading. Key informants inform further that such people perform the petty trading processes within and outside The North Nguu Mountains. Information indicate further that those who engage in petty trading are linked to the crop farmers, livestock keepers, collectors from the forest, as well as, hunters for trading products but also for adding value to the products for generating more income when trading. Information from discussions from all the study villages indicated further that petty trading employs a moderate portion of the labour force from individuals, families and households in the area.

Text box 6.5 presents information on people's engagement in petty trading by a farmer in Kwediboma village.

' ... apart from crop farming mainly maize and beans ... I also keep six local chicken and four rabbits ... I sometimes engaged in trading my farm crops and livestock products including some forest and game products ... that's how I earns my living with my family... ' (A farmer: Kwediboma village, 2011)

Text Box 6. 5: Petty trading in Kwediboma village

Source: Field Data (2012)

Figure 6.7 and 6.8 present petty trading processes as a support to livelihoods and the economy for individuals, families, and households in Lulago and Kilindi villages.

Figure 6. 7: Trading maize and beans in Lulago village

Source: Field Data (2012)

Figure 6. 8: Farm-gate tomato selling in Kilindi village

Source: Field Data (2012)

6.2.5 Hunting and mining prosperity

Only 6.8% of respondents (Table 6.1) indicated to be making part of their living mainly through hunting and mining prosperity. Additional information from discussions including in-depth interviews with key informants from all the study villages indicated that although restricted by the country's regulations, hunting especially for food intake and a small part for income generation exist in villages within The North Nguu Mountains.

Further information from key informers revealed that hunting is normally not done by everybody who wants to do it anyway. Interview with key informants revealed further that hunting as a livelihood strategy is done along family and clan lines. It is a practice that is commonly done by specific people (individuals, families and or households) in specific localities who normally inherit it from their parents and grandparents. Generally, similar to collection from the forest, hunting (as a livelihood strategy) scored lower even more than collection from the forest during this study further lower than crop farming, livestock keeping and trading.

Further information from key informants indicate that some people who are coming in and out of the villages more frequently are mostly coming in for mining. Some of such people engage in trading game products and gemstone. The key informants inform further that such people who come for hunting are in close touch with the consumers of both game products and gemstone within and outside the area. As mentioned before in this chapter, those who engage in hunting and mining are also linked to traders of the game products and gemstone.

Even though, further discussions from all the study villages indicated clearly that hunting and mining employs a relatively low portion of the communities in the area. Key informers from all the study villages revealed that most people who make their living partly on hunting are engaged in the hunting processes seasonally and that there are times when they switch to different livelihood strategies depending on the weather conditions and prey situations in the area by that time. A key informer from Lulago village revealed, for example, during interview that the main market (for game meat and other game products) within the village and other nearby villages surrounding Lulago village is normally during the dry season but the market is open almost throughout the year in big towns within and outside the area. Supply of game meat and other specific bits and pieces from game products from the villages to the outside markets (trading on game products) is mainly done by traders. However, observations during this study indicate that there exist touristic professional hunting in the Handeni Game Controlled Area close to The North Nguu Mountains north of Kilindi district. Figure 6.9 present prey in the *miombo* woodlands.

Figure 6. 9: Game *'swala'* in Kilindi village

Source: Field Data (2012)

6.2.6 Traditional ceremonies and ritual services

Only a small proportion of 1% (Table 6.1) indicated performing ritual ceremonies including use of medicinal plants and specific bits and pieces from game for curative purposes to livestock and the human to be used as main strategy for making their living in The North Nguu Mountains. Similar information was generated from interview where a key informer from Kilindi village informed that there are people who make their living on performing ritual services for prevention and curing services to both livestock and the human. Such people have contacts with customers within and outside the area.

Information revealed further that there are people who come for the traditional prevention and curing services from diseases for the human and livestock within and outside The North Nguu Mountains. However, traditional ceremonies and ritual services have generally been scored very low by all respondents throughout the study and this indicates clearly that the strategy is still diminutive as a livelihood strategy that can reasonably and effectively support people for making their living effectively in the area. Note that although it was evidently clear during this study that people make their living out of logging and timber works, no body mentioned anything to do with logging or timber works during this study.

Information indicated further that given their catchment value, forests in The North Nguu Mountains are all protected by the government as Catchment Forest Reserves. Communities in the area have since then been used to the situation that logging is not allowed. Logging and timber works can only be performed freely in communal

lands, woodlots and private tree plantations but not in protected forests i.e. forest reserves. Note also that by explaining their daily living processes, the local people already outlined the livelihood assets available in The North Nguu Mountains.

When explaining their daily living processes, the local people attached the resources and processes that they utilize to make their daily living. It is also clear from this study that the collection of specific bits and pieces from game and the non-timber forest products together with hunting are all strongly connected to petty trading. Information indicate further that both hunting and collecting from the forest avails valuable products for home consumption and petty trading. It is also very clear from this study that traditional practices on ritual services are very diminutive for supporting living by themselves in the area.

Findings from this study and particularly in this section are similar to information from findings by Siege L. *at al*, (2003) in a study on Selous Game Reserve (SGL) have the information that Selous is one of the largest forest areas under protection for game in Tanzania. Due to its unique ecological function and productivity, as well as, the hunting quota system, livelihoods in the area have been growing sustainably. Nevertheless, UNEP (1995) informs further that, the world's poor depend critically on healthy ecosystems for their livelihoods where biodiversity provides significant economic, aesthetic, health, and cultural benefits that form the foundation for livelihoods. But generally, findings in this study reveal that crop farming and the nomadic agro-pastoral system seem to be the common livelihood strategies in The North Nguu Mountains.

6.3 The Impact of Climate Change on The Livelihood Assets

6.3.1 The impact of climate change on the forest

The forest has been referred to by communities during this study as a fundamental livelihood asset to the daily living systems of the people in The North Nguu Mountains. However, communities were drawn during the discussions to use land and the forest interchangeably. It was difficult for communities to mention the forest without mentioning land. Discussions on the forest in The North Nguu Mountains links to land use systems. Note that land use (including the forest) conflicts were key issues for discussions when addressing the impact of climate change and pressure on the forest during this study.

Findings reveal that the forest has to a very big scope referred to by communities during this study as a livelihood asset that is fundamental to their daily living in the area. When discussing in detail potential of the forest, communities ended up discussing the rainfall regulation function of the forest including provision of water for livelihoods. Information reveals further that land (including the forest) and rainfall (for water) is the key and fundamental assets that make the baseline for livelihood systems in The North Nguu Mountains.

General comments from communities indicate further that the frequent changing weather conditions affects negatively the forest health, as well as, production and productivity of the forest ecosystem. Communities see such situations to impact negatively on supply of goods and services from the forest ecosystem such as supply of water, timber and the non-timber forest products thus affecting the forest linked

rural livelihoods. Table 6.2 presents information on the impact of climate change on the forest as revealed by communities during this study.

Table 6. 2: The impact of climate change on the forest

No.	The impact of climate change on the forest	No.	%
1.	No impact	0	0
2.	Pressure on the forest	596	47.8
3.	Unsustainable forest production and productivity	372	29.8
4.	Unsustainable forest linked livelihoods	182	14.6
5.	Income poverty	98	7.8
	Total	**1,248**	**100.0**

Source: Field Data (2012)

a). Pressure on the forest

i). Land use systems

None of the respondents during this study mentioned climate change to have no impact on the forest in all the study villages (Table 6.2).

Moreover, a total of 47.8% of all respondents observed pressure on the forest to be the leading and critical impact of climate change on the forest in the area. Also, information from discussion sessions, as well as, from key informants in all the study villages comply with information from questionnaire interview that the impact of climate change on livelihoods emanates from pressure on the forest in the area. Generally, pressure on the forest came out strongly when conducting this study. Text Box 6. 6 presents comments from a community member on land use conflicts in

Kilindi village whereas Figure 6.10 and 6.11 present uncontrolled tree felling and forest fires that are considered as pressure on the forest that accelerate land use conflicts in Kwediboma and Gombero villages.

> '… management of range lands including pasture or grazing land remains to be core to my living … however, given the accelerating rate of land and forest degradation in this area, land use conflicts are on the rise … but I think … the problem becomes much more difficult to handle because … land use conflicts particularly in our village result from the operational functioning of … crop farming and livestock keeping … the two sets of living systems takes place without a clear structure or system … the forest becomes the hosting ground for the conflicting interests or requirements … thus pressure on the forest … ' (A farmer: Kilindi village, 2011)

Text Box 6. 6: Resolving land use conflicts in Kilindi village

Source: Field Data (2012)

Figure 6. 10: Uncontrolled tree cutting and logging in Kwediboma village.

Source: Field Data (2012)

Figure 6. 11: Uncontrolled fire in the forest – Gombero village.

Source: Field Data (2012)

Text box 6.7 presents information from a livestock farmer in Kwediboma village on co-existence of crop farming and livestock keeping in the village.

> '… last year (2010) our representative went to lobby for the huge unutilized land close to our settlements so that we can put it under grazing. The feedback was crop farmers have already requested the same land for crop farming. We decided to go ahead asking it at higher levels because our friends in town encourage us that pastoralism is nowadays in Tanzania recognized at policy level as a formal livelihood system so we should continue lobbying. The only thing our friends warned us was not to interfere with protected areas ...' (A farmer: Kwediboma village, 2011).

Text Box 6. 7: Co-existence of crop farming and livestock keeping in Kwediboma village.

Source: Field Data (2012)

Information from this study indicates also that lack of land use plans is the root cause of land use conflicts and ultimately unsustainable land management. It was observed

that pastoral communities lobby land to prevent crop farming where crop farmers do the same to prevent free grazing.

However, there is a general recognition amongst communities that free access to the rangelands for farming or grazing at the expense of the forest will soon not be possible anymore and that probably they need to change, adjust or adapt their livelihood systems to comply and fit in within the recommended land use practices and sustainable land management.

ii). Migration and resettlements

Discussions reveal that the common in and out migration processes such as the nomadic pastoral lifestyle resulting into the mobile and or on-transit land use systems both emerges and results into pressure on land hence conflicting land uses. Communities agreed together during discussions that the influx of in-migrants in the area accelerates pressure on land and the forest. Text box 6.8 presents information from a key informant from Kilindi village on migration and resettlements.

> '... the in-migrants issue is part of the problem when it comes to land use conflicts ... they exert pressure on both land and the forest such that we cannot extend crop farming nor utilizing the vast land we have for grazing ... tree felling for establishing new settlements is now a problem and it needs immediate attention by the authorities...' (A farmer: Kilindi village, 2011)

Text Box 6. 8: The need for sustainable land management

Source: Field Data (2012)

However, information from discussions in Kilindi village reveals a huge potential from the in-migrants in the villages such as establishment of new settlements in

distant forested areas somehow helpful in intensifying security against illegal and uncontrolled forest harvesting in the village; trading becoming more live, viable and profitable to the business community in the villages i.e. in-migrants creating an easy market for farm, livestock, forest and game products in the villages thus trading becoming more vibrant in the villages.

Figure 6.12 and 6.13 present clearing of the forest for establishment of new settlements for the in-migrants (particularly those coming in for grazing i.e. the agro pastorals including those who are moving in for mining prosperity and other livelihood strategies that are supported by the forest) within the vicinity of Kwediboma village on the road to Lulago and other nearby villages within the area.

Figure 6. 12: Clearing the forest for new settlements - Kwediboma village.

Source: Field Data (2012)

Figure 6. 13: Clearing the forest for new settlements - Kilindi village.

Source: Field Data (2012)

Communities revealed that the extended social interactions with the in-migrants exposed the local communities to acquire new ideas for livelihood diversification as an option for adaptation in the area. Similarly, a key informer from Kwediboma village revealed that people clear the forest for better crops while the pastoral livestock keepers clear the forest for pasture. Crop farmers move closer to the forest for forest moisture and the pastoral cattle keepers go inside the forest for pasture and water. Text box 6.9 present information from a farmer on the impact of in-migrants.

> ‘ ... I normally extend my farm towards the forest ... because land adjacent to the forest is more productive ... cattle keepers bring cattle close to my farm for rich natural grass... my wife collects enough fuel wood including wild vegetables and fruits ... from the forest ..... but the in-migrants now take away everything for themselves ... they look for land... they look for livestock ... they look for anything to sell in the market ... the forest is not that much to give them all these ’ (A farmer: Lulago village, 2011)

Text Box 6. 9: The impact of in-migrants debate in Lulago village.

Source: Field Data (2012)

The two cases indicate clearly the way that pressure on land leads to pressure on the forest. Often, climate change is the initial cause but it accelerate also such cases. Text box 6.10 presents informant from a farmer on in-migrants in Lulago village.

> '... I moved out of the village centre back to top of the mountain with my two goats and four sheep because people from outside this area came in with cattle ... they take as much land as they want ... I don't feel comfortable ... I've decided to come back to my former village ... where I can move easily into the forest for my living ... ' (A farmer: Lulago village, 2011)

Text Box 6. 7: Influx of in-migrants in Lulago village

Source: Field Data (2012)

b). Unsustainable production and productivity of the forest

About 29.8% of the respondents from all the study villages observed that unsustainable production and productivity of the forest was a result of the impact of climate change. Generally, information from discussions on the impact of climate change on the forest with gradient at the daily livelihood systems in all the study villages concur with information from questionnaire interview that climate change results more in a declining trend of production and productivity of goods and services from the forest ecosystem including diminishing rainfall moderation function of the forest in the area.

Detailed information from discussions reveals that such a situation results further in water shortage from declining rainfall in the area. Information on the impact of climate change on the forest reveals further that the declining supply of goods and services from the forest ecosystem in the area include declining supply of pasture

including game feed for the *herbivore* in the range lands reduces income to communities. This reduces also the influx of hunters from outside the area.

Detailed discussions revealed further that the impact of climate change to the forest results in the deterioration of the forest health thus diminishing of the forest linked employment opportunities together with all the natural resources scenarios emerging from the natural mountain-forest in the area. Text box 6.11 presents information from one key informant from Kilindi village on the declining forest production and productivity function in the village.

> '... when an illegal timber dealer gets into the forest for logging something not allowed in our village ... quite a number of other trees fall down destroying a huge volumes of wild vegetables, fruits and berry ... all these get destroyed before they are picked up for use ... this influences also declining income from the forest in our village ... in the past for example, you only wanted to have two medium size *sambu* trees to have *sambu* nuts enough to fill a one liter container with *sambu* oil ... but today you need to go around five to seven *sambu* trees of the same size in order for you to collect *sambu* nuts enough for the same size of a container ... the *sambu* trees are almost disappearing from the forest ... the few remnant *sambu* trees do not produce enough as it used to be in the past ... !' (A farmer: Kilindi village, 2011)

Text Box 6. 8: Declining forest production and Productivity, Kilindi village.

Source: Field Data (2012)

Note that '*sambu*' is a wild fruit tree from '*allanblackia stuhlmannii*' from which the '*sambu*' nuts are picked and locally processed into cooking fat for home use and trading within and outside the area. Discussions on unsustainable production and productivity of the forest reveals further that uncontrolled or unplanned hunting and collection of specific bits and pieces from game, wood and the non-timber forest

products from the forest accelerated forest destruction and thus the forest health. This in turn results in diminishing employment opportunities for communities in the area particularly from people on study visits including visitors to the forest for tourism, leisure or recreation pursuits in the area.

The other factors that were discussed and agreed upon by communities to induce or accelerate unsustainable production and productivity of the forest resource in the area include the mobile and or on-transit land use systems of the agro-pastoral communities. The mobile or on-transit land use systems have been agreed to be both root causes and accelerating factors for unsustainable production and productivity of the forest as it creates pressure on land and the forest in the transit areas and the selected areas for temporal settlements by the agro-pastoral individuals, families, households and sometimes even groups from distant places to The North Nguu Mountains. Through further discussions with communities during this study, it was revealed further that changing health of the forest due to pressure on the forest influenced also production and productivity of the forest thus affecting supply of goods and services from the forest ecosystem.

Goods and services from the forest ecosystem that were referred to by communities during discussions when conducting this study include compost manure that drains to the downstream valley bottoms crop fields, water and pasture for livelihood systems in the area. These include also timber and the non-timber forest products such as wild vegetables, fruits, berries and jelly, honey game, as well, as game products. A key informant from Kwediboma for example express problems resulting from pressure

on the forest to also be accelerated by the forest potential for livelihoods in the area. The key informant gives an example as presented in Text box 6.12

> ‘ ... cattle keepers normally take cattle inside the forest for grazing and watering during the dry seasons ... the cattle tracks inside the forest develops to significant erosive points that accelerate gully erosion ... this action slows down erosion and degradation of the forest … but crop farmers approach and do it differently ... they harvest and clear the forest for crop fields and work on the field continuously and permanently ... this destructs the forest ... ‘(A farmer: Kwediboma village, 2011)

Text Box 6. 9: Pressure on the forest and livelihoods

Source: Field Data (2012)

Text box 6.13 presents information from a key during discussions on production and productivity of the forest resource in Kwediboma village.

> ‘ ... uncontrolled tree felling and forest fires are induced by... spark-off from locally made firearms in dry bushes during hunting including traditional honey hunting... fire is also used to scare cattle keepers from grazing near crop fields ... but also cattle keepers use fire to prepare areas for sprouting of new grass before the rains and also to scare crop farmers from opening crop fields close to the grazing fields ... some people use fire to get rid of ticks and insects that are dangerous for livestock and the human ... fire outbreaks from arson or wanton damage mostly by children, youth and passing by strangers are also very common ... ‘(A farmer: Kwediboma village, 2011)

Text Box 6. 10: Production and productivity of the forest in Kwediboma village

Source: Field Data (2012)

c). Others

A total of 14.6% of the respondents from all the study villages (Table 6.1) observed the impact of climate change on the forest to result in unsustainable rural livelihood

strategies and or systems. Moreover, a total of 7.8% of respondents from all the study villages observed that the impact of climate change on the forest results in income poverty to communities in the area.

6.3.2 The impact of climate change on rainfall

Information revealed in Chapter 4 and 5 indicate rainfall to be the main water source in The North Nguu Mountains. Communities therefore discuss rainfall in the light of the water provision function for livelihoods. Despite the detailed information from instrumental records particularly on the actual rainfall data as presented in Chapter 5, with provision of water, rainfall remains to be one of the main livelihood assets in The North Nguu Mountains. The actual rainfall data as presented in Chapter 5 provides statistical views and status of the impact of climate change on rainfall with some mind's eye only on livelihood performances in the area. It is therefore pertinent to continue ground too thing for the recent readily available insights on the impact of climate change on livelihoods through rainfall in the area. Generally, information from the field indicate that if no rainfall in the area, then there is no water thus no life. Text box 6.14 presents information on rainfall, water availability and climate change in Kwediboma village.

> '... Kwediboma village was in the early 1960s, receiving heavy rainfall with high volumes of water resulting in heavy surface drainage ... frequent flooding ... some parts of the village were inaccessible for a month or so, but now ... the situation is different ... no rains ... no water ... life is very difficult ... I now agree that ... if no rainfall, then no life ... ' (A farmer: Kwediboma village, 2011)

Text Box 6. 11: Rainfall, water availability and climate change in Kwediboma village.

Source: Field Data (2012)

Figure 6.14 and 6.15 presents the situation in Lulago village on a rainy day during the short rains in November 2011.

Figure 6. 14: A rain event in Lulago village

Source: Field Data (2012)

Figure 6. 15: Mist in Lulago village

Source: Field Data (2012)

A farmer summarized ideas on the impact of climate change on livelihoods with respect to land use conflicts as presented in Text box 6.15.

> '... a decline in rainfall results in water shortage for domestic use, crop farming and livestock ... the cattle keepers march into water points for watering cattle ... crop farmers divert surface runoff from water points to the farm plots for irrigation ... whereas everybody else struggle to get same water for domestic use ... this gets the whole community in water use conflicts in the village ...' (A farmer: Kilindi village, 2011)

Text Box 6. 12: Climate change and severe land use conflicts

Source: Field Data (2012)

A community member in Lulago village had some comments on rainfall and crop farming in the village as presented in Text box 6.16

> Kilindi village was before 1950 receiving strong and timely rain storms throughout the year .... there was plenty of water ..... the village was evergreen throughout the year .... ! People in this village started to experience some changes on planting seasons from the late 1960's. I think this is just because the rainy seasons has lost its course! Before, one could delay for some few days or a week and so .. in following the crop or farming calendar ... the farmland were always wet throughout the year, planting was possible anytime of the year ... harvesting was definite! (A farmer: Kilindi village, 2011)

Text Box 6. 13: Rainfall and the changing crop calendar in Lulago village.

Source: Field Data (2012)

In an interview with a key informant from Kilindi village on the same topic, it was revealed further that traditionally, communities pay a strong and special attention to the huge natural forest on top of Kilindi Mountain (now The Kilindi Catchment Forest Reserve) in the village which they believe to be potential for water availability in all the water sources found in the village. Communities agreed during discussions

that the forest on top of Kilindi mountain performs the rainfall moderation function providing water to people and also livestock, game and all other living creatures including *flora* and *fauna* found downstream the huge open acacia '*miombo'* woodlands in the area.

Generally, communities that were involved in interviews and discussions in all study villages admit to have heard from their elders that in the past, before the 1920s, the area experienced strong rain storms that were experienced again in 1958, 1969 and in the mid-1980s on a declining trend. People admit further that since year 2000 rainfall performance has been very poor and the area receive very shallow rains compared to previous years in the area. Though there was some periods of poor rainfall events in the past, this information goes parallel to data on the rainfall pattern and rainfall events for a period of 10 years intervals from 1980 to 2000 in the area as presented in Chapter 5.

The key informant from Kilindi village made another comment during discussions arguing that crop farmers are not able to grow even vegetables leave alone cereals for food and for trading. Generally, the key informer emphasizes rainfall to be the sole water source in the village for livelihoods including other environmental issues. Information on climate change, rainfall and livelihoods drew the attention of other community members during discussions making them agree on the declining function of the forest on rainfall moderation to be the root cause of poor rainfall and thus diminishing water in the area. The main issue of interest for this study during the discussions was information on the impact of climate change on the forest and its

effects on rainfall. Rainfall emerged as the only source of water in the area as revealed earlier by communities during this study. Information on water availability emerged when discussing climate change and potential of the forest for the rainfall moderation function whereas, information on water use emerged when discussing climate change, livelihoods and the options for adaptation. Nevertheless, information on the possibility and effectiveness of water availability from other sources in the area was raised higher during discussions. The issue entailed more technical and social economic factors with some political and cultural influences on sustainable livelihoods and the options for adaptation in the area. Therefore, though very important for the people's daily living in the area, ideas and strategies for availability of water from other sources were perceived as options for adaptation in this study.

6.4 The Impact of Climate Change on People's Daily Living

When responding to the impact of climate change on the forest as presented in Section 6.2, communities indicated climate change to result into unsustainable livelihoods and income poverty to communities. However, additional discussions and interview sessions on the impact of climate change on livelihoods were conducted further to all members of the study sample from all the study villages.

All members of the study sample responded to a set of questions that inquired about their knowledge on the general impact of climate change on their daily living in the area. Generally, information on the impact of climate change on livelihoods indicates clearly problems emanating from increasing land use conflicts in the area, changing production and productivity of land and the forest, as well as, changing

production and productivity of crop farming and livestock keeping to be the most visible impacts of climate change that affects people's daily living in the social economic and environmental aspects. Table 6.3 presents responses on the general impact of climate change on people's daily living in The North Nguu Mountains.

Table 6. 3: The impact of climate change on livelihoods

No.	**The impact of climate change on livelihoods**	**No.**	**%**
1.	Land use conflicts	263	21.0
2.	Changing production / productivity of land and the forest	234	18.7
3.	Changing production and productivity of crops / livestock	170	13.6
4.	Changing supply of goods and services in petty trading	101	8.1
5.	Changing water levels and salinity (flooding and or drought)	81	6.5
6.	Health and quality of the forest	82	6.6
7.	Changing human and livestock health	53	4.2
8.	Community members not attending communal works	54	4.3
9.	Difficulty for children to attend school programme	35	2.8
10.	Unsustainable communal infrastructures	50	4.0
11.	Unsustainable livelihood systems and income levels	127	10.2
	Total	1,250	100.0

Source: Field Data (2012)

Generally, the study grouped information from the local community on the impact of climate change into environmental, economic and social chains as follows:

6.4.1 The environmental impact

a). Land use conflicts

A total of 21% of the respondents on the impact of climate change on livelihoods considered the increasing land use conflicts to be among the leading impacts of

climate change in the area. Despite being listed under environmental factors, land use conflicts register also some social and economic impacts on livelihoods. During discussions, the Village Executive Officer – VEO for Kilindi village noted that land use conflict issues were top of agenda in the village. The VEO continued saying that the village government has already for a period of six months before the period of this study forwarded a total of four land use conflict issues to the ward office and two more to the primary court at ward level. Text box 6.17 presents information on managing land use conflicts in Kilindi village.

> ‘ ... at least four out of five disputes that are brought for attention by the village government are land use related disputes ... generally, the situation on land use is getting worse ... the main conflicting land uses are crop farming and livestock keeping ... the two land uses can easily through land use agreements ... however, the frequently changing faces of the pastoral cattle keepers in our village is a problem ... ‘ (VEO: Kilindi village, 2011)

Text Box 6. 14: Resolving land use disputes

Source: Field Data (2012)

b). Health and quality of the forest resources

About 6.6% of respondents on the impact of climate change on livelihoods considered poor health and quality of the forest resource to be an impacting factor of climate change on livelihoods that bears also an environmental impact in the area. Discussions were mainly referring to livelihoods that are directly linked to the forest such as use of timber including wood products, as well as, use of the non-timber and non-wood forest products such as wild vegetables, fruits and jelly including natural grass to support living. As reported in this study, the impact of climate change on the

livelihood assets i.e. land and the forest apply also to the impact of climate change on livelihoods. Text box 6.18 presents information on livelihood diversification by a farmer from Kilindi village during discussions when conducting this study.

> ‘ ... There are very few people who can afford to keep a family by depending on the forest ... people diversify their living strategies because nothing in material form that is coming out of the forest is worth depending upon for living except if you happen to come across minerals such as gold ... the forest supported living in the past ... not now ... ’ (A farmer: Kilindi village, 2011)

Text Box 6. 15: Ideas on livelihood diversification

Source: Field Data (2012)

c). Water volumes and salinity levels

There were no measures of salinity level in water that were taken during this study. However, a total of 6.5% of respondents on the impact of climate change on livelihoods considered climate change to have impact on water volumes and salinity levels thus influencing the difficult situation on livelihoods in the area. Two farmers from Kwediboma village were involved in a debate among themselves on the changing water levels and the water salinity aspect. This happened when both community members were waiting for their turn to the interview and they started talking their experience on the water issue in the village. In the process, the other members of the study sample got into the discussions. Text box 6.19 presents ideas from one of the farmers who was involved in the discussions.

> ‘... when it rains long ... we find ourselves in a flooding situation but with plenty of water that is clean and sweet ... but when the stops, then ... the little water available is salty and not clean ... I really don’t know because I don’t like a flooding situation ... but I also don’t like unclean and salty water ... probably it is high time now we consider getting clean and safe water for domestic use from other sources but not in a flooding situation .....’ (A farmer: Kwediboma village, 2011)

Text Box 6. 19: Ideas on the options for adaptation

Source: Field Data (2012)

But the other farmer opposed the fellow farmer by reminding her that water volumes and salinity levels or flooding including drought events are actually temporary and short term phenomenon. Such event come and go! But despite being temporary, the water issue carries weight in people's living in the village. Text box 6.20 presents information on water and livelihoods.

> ' ... water availability and water quality are real things that we've to worry about in our village today ... it is not only the availability ... cleanness ... and the water taste ... if the volume of water goes down it affects crop farming and even livestock and game ... but also if water becomes too salty it again depends ... it may affect crops probably livestock, game and the green cover in the forest ... generally, this situation affects our living here in the village ... not only food but our living including our economy base now and in the future for our children...' (A farmer: Kwediboma village, 2011)

Text Box 6. 16: Ideas on water and livelihoods

Source: Field Data (2012)

6.4.2 The economic impact

a). Production and productivity of land and the forest resources

About 18.7% of respondents on the impact of climate change on livelihoods considered the change in production and productivity of land and the forest resources with a direct and negative impact on people's daily living in the area to result from climate change. Text box 6.21 presents information on changing weather conditions and livelihoods from a pastoral livestock farmer in Gombero village.

> ' ... the changing weather conditions over time result in lack of fodder and also diminishing quality of the little fodder available ... this makes livestock to lack fodder and water ... we've to go far for pasture and water ... health of the livestock goes down ... volume and quality of the livestock products goes down also ... this applies also to volume and quality of farm crops ... generally, food and income becomes a problem ... '(A farmer: Gombero village, 2011)

Text Box 6. 17: Changing weather conditions and livelihoods

Source: Field Data (2012)

Another community member from Kwediboma village argued when discussing during this study as presented in Text box 6.22

> ‘ ... I used to send my granddaughter to collect firewood for me ... she spends a little time and comes back with firewood that takes me three to four days ... the girl is not here any more ... if I want firewood today I’ve to send a labourer who goes a little far inside the forest and come back with a little pack of firewood that takes me one day only ... it’s now difficult as I’m paying for the service, it takes long to get the firewood and I’m getting less ... ’ (A farmer: Kwediboma village, 2011)

Text Box 6. 18: Changing the forest health and livelihoods

Source: Field Data (2012)

b). Production and productivity of crops and livestock

A total of 13.6% of the respondents on the impact of climate change on livelihoods considered the change in production and productivity of crops and livestock to result from the impact of climate change in their respective areas. An old man who was involved in this study revealed that he used to harvest 60 bags of maize (100 kgs each) from his 4 acres farm plot. He did this in the last 25 years. Text box 6.23 presents information of an elder from a cattle keeping family in Kwediboma village who was present during the discussions.

> ‘ ... we, cattle keepers, normally select and milk a certain number of cows to feed the family and milk the rest separately to sell the milk for income... if milk goes down, could be during dry spells or the number of family members increases and sometimes visitors staying long with us ... we normally increase the number of cows that we milk for the family and reduce the amount of milk for selling ... today we’re almost engaging fully in crop farming ... this sound strange ... we’re not used to this ... ’ (A farmer: Kwediboma village, 2011)

Text Box 6. 19: Adaptation options for in livestock keepers

Source: Field Data (2012)

But the farmer admits the number of maize bags from the same farm plot to be going down to only 5 bags of maize i.e. same volume and same weight (100kgs) during the time of this study, Production dropped further to 5 bags only during the period of this study. The old man admitted that the situation has been attributed to by the accelerated changing weather conditions in the area.

Information from detailed interview and further discussions on the impact of climate change on production and productivity of crops and livestock indicate further that since crop farming and livestock keeping are the commanding livelihood strategies in The North Nguu Mountains, an impact on production and or productivity in crop farming and livestock keeping affects also livelihoods for the majority of the people in the area. However, communities were aware during discussions that apart from changing production and productivity of crop farming and livestock, use of quality agronomic and veterinary packages and products influences the situation also.

c). Living conditions and income levels

A total of 10.2% of the respondents on the impact of climate change on livelihoods considered climate change to have a direct influence on the living conditions and income levels in the area. Text box 6.24 presents information on the human factor in livelihoods and climate change.

> '...crop farmers claim not to be getting enough, they turn to supplementary livestock keeping ... the cattle keepers also claim not to be getting enough ... they turn to supplementary crop cultivation ... those collecting from the forest claim not to be collecting enough ... they turn to hunting ... the hunters claim not to have enough prey... they collecting from the forest ... I think we're all part of the problem by looking for survival only ... ' (A farmer: Lulago village, 2011)

Text Box 6. 20: The general options for adaptation

Source: Field Data (2012)

d). Supply of goods and services in petty trading

A total of 8.1% of the respondents considered climate change to have impact on supply of goods and services for petty trading. This aspect was discussed and agreed upon by all members of the focus discussions sessions in all the study villages. It was further agreed during discussions that apart from the industrial merchandise including forest and game products, a big portion of goods and services for trading are mainly farm crops including livestock and livestock products that by their nature and the prevailing processing standard in the area, such products (perishable products) are highly affected by time span and climate change in general in the area.

A key informer from Kwediboma village said during interview that by affecting production and productivity of crop and livestock products, climate change affects also supply of goods and services from crop farming and livestock in the market. The informer noted that crop farmers and livestock keepers apart from using the crop farming and livestock products for food, they also depend on trading for them to make some earnings that are basic for their living.

The informer continued saying that most of the communities in The North Nguu Mountains are crop farmers and livestock keepers. When crop farming and livestock keeping together with trading are all not supporting their living then it simply means that the impact of climate change on crop farming and livestock keeping affects also trading and hence livelihoods for more than half of the population and the economy in the area. Crop farming and livestock keeping therefore are pillars for livelihoods in the North Nguu Mountains.

6.4.3 The social cultural impact

Normally, discussions on migration, settlements, resettlements and reallocation in villages sounds more of social cultural nature despite having also some environmental and economic outlooks. However, experience in this study shows that migration and resettlement influence and accelerate land use conflicts hence affecting the land linked livelihoods in the area. A community member from Kilindi who took part in focus group discussions in the village made some comments on resettlements and reallocation to be applied by people from within and outside the area as options for adaptation hence difficult to administer. Text box 6.25 presents the villager's comments on migration and resettlements in Kilindi village.

> From last year (2010), the village experienced intensive crop farming, increased pastoral grazing systems, as well as, establishment and expansion of settlements close to water sources mainly done by people from outside this area … the situation continued like that and as of now, only one year after, people are settling in the water logged *Mshana* valley... once a rich bottom valley water body that was full of natural endowments for life such as fish but now a poor dry settlement area ... no even the normal green vegetables ... ! (A farmer: Kilindi village, 2011)

Text Box 6. 21: Migration and settlements in Kilindi village

Source: Field Data (2012)

The study spent some time to discuss with one key informer who happened to be a councilor from Kwediboma village. Text box 6.26 presents information on average size of crop farm plots and herd of cattle in the study area

> '... crop farmers stay together with the nomadic agro-pastorals in The North Nguu Mountains ... a crop farmers household maintain an average of 5 – 12 cattle and 5 sheep or goats only ... an agro pastoral maintain up to 200 herds of cattle and 250 sheep or goats ... the mobile land use is therefore inevitable to the agro pastorals for water and feed ... while the crop farmers can manage zero grazing ...' (A farmer: Kwediboma village, 2011)

Text Box 6. 22: Size of crop fields and cattle herds

Source: Field Data (2012)

Text box 6.27 presents information on the mobile land use in The North Nguu Mountains as presented by a farmer in Kwediboma village.

> '... all those who are moving in and out of the village are basically trying to diversify and sustain their strategies for living and or the options for adaptation ... without causing disturbance to other people in the areas where they are coming from ... moving out of the village is therefore to me an option for adaptation ... ' (A farmer: Kwediboma village, 2011)

Text Box 6. 23: Climate change and the mobile land use

Source: Field Data (2012)

The other social effects of the impact of climate change as revealed during this study include poor attendance of community members in communal works (4.3%), human and livestock health (4.2%), destruction of communal infrastructures (4.0%), as well as, attendance of children in school programmes (2.8%). Text box 6.28 presents information on the impact of climate change to a young family in Kwediboma village. A villager who presented this information considered the impact of climate change to i.e. a social impact to a family as social structure. Text box 6.28 presents the impact of climate change on a family as a social unit, structure or institution.

> ' ... lack pasture and water for cattle compel men to go out with cattle for grazing and water ... last year it was my husband's turn to go ... it took him three months before he was back for a moment and then went back again for almost a year ... when he was back, I was already having our first new born baby ... I don't understand what was going on with him but he just said he's not responsible for the new baby and therefore I've to maintain the links with the father of the baby so that he'll assist taking care of the baby ... our marriage nearly got broken ... he was away for quite long ... he went alone and I stayed back alone for quite long ... we're all still new to each other ... now we have a new born baby but ... but we're all not happy... ' (A farmer: Kwediboma village, 2011)

Text Box 6. 24: The impact of climate change on performance of a family (as a social unit).

Source: Field Data (2012)

Further discussions revealed that though not very open, but it was certain during this study that the family was for sometimes broken loose i.e. the husband wife relationships were not very binding given misunderstandings and mistrust among the husband and wife. They (husband and wife) could not sit and plan together. People that were involved in the discussions during this study attach the incidence to the impact of climate change.

6.4.4 General findings on the impact of climate change on livelihoods

Information presented in this Chapter embodies the social, economic and environmental chains for livelihoods in the area as revealed through general discussions with communities and additional information from the key informers. Generally, data from interview indicate the impact of climate change on livelihoods in the area to be among others land use conflicts; changing production and productivity of land and the forest; changing production and productivity of crops and livestock; changing supply of goods and services in petty trading, as well as, changing water levels and salinity (flooding and or drought). The other impact of climate change on livelihoods include health and quality of the forest; changing human and livestock health; difficulty for community members to attend communal works; difficulty for children to attend various school programmes in the area; unsustainable communal infrastructures that all together contribute to unsustainable livelihood systems and income levels in the area.

Generally, the impact of climate change induces and or accelerates destruction of the social economic and environmental chains for livelihoods in the area. Table 6.5 presents summary of the general impact of climate change on livelihoods.

Table 6. 4: The general impact of climate change on people's living

Livelihood	**The impact from climate change**
Crop production	Decreasing land productivity and crop production, expansion or opening up of new crop farms at the expense of the forest, food and income insecurity, poverty.
Livestock keeping	Decreasing production and productivity of livestock leading to encroaching on the forest for grazing and water resulting in food insecurity, low income and poverty.
Hunting, collection	Decreasing production and productivity of game, destruction of the forest (pressure on the forest), food insecurity, low income and poverty.
Trading	Decreasing supply of crop farming and livestock products, diminishing forest and game products for food and trading, low income and poverty.

Source: Field Data (2012)

Figure 8.1 presents the conceptual link between climate change, the forest, rainfall and livelihoods as derived from this study.

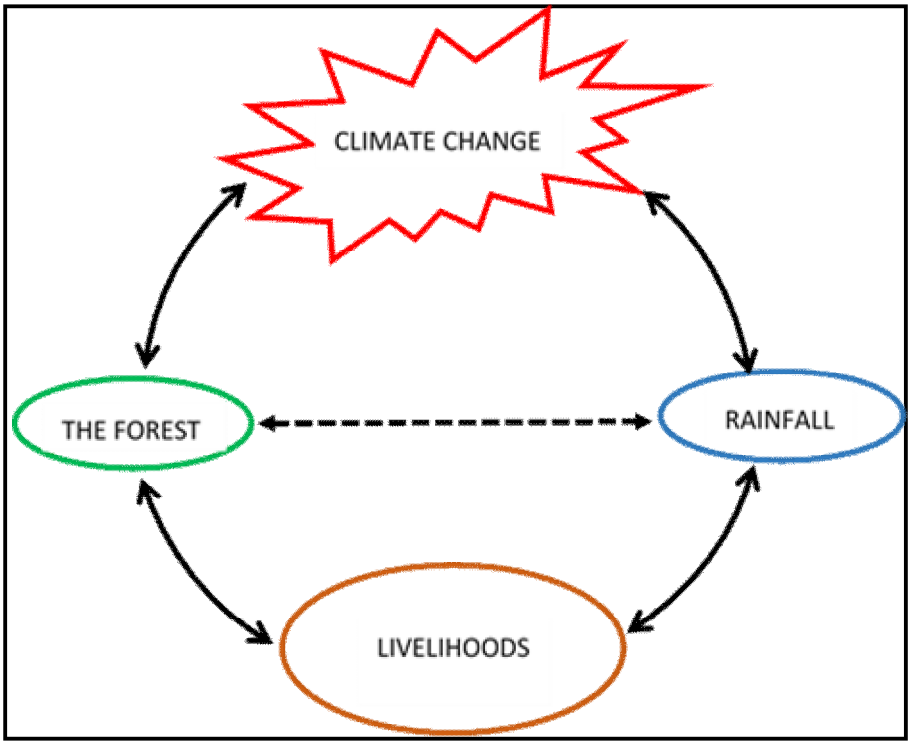

Figure 6. 16: The conceptual link climate change and livelihoods.

Source: Field Data (2012

This study revealed generally that both climate change and livelihoods in The North Nguu Mountains influence each other directly through the forest and rainfall (as livelihood assets in the area). The forest and rainfall have also a direct influence on each other, as well as, on climate change and livelihoods in the area.

Generally, when analyzing the findings on the impact of climate change on people's daily living in The North Nguu Mountains, livelihoods that were mentioned to be affected more by climate change include those that are directly linked to land and the forest resources. This is mainly because land and the forest are fundamental assets for livelihoods and adaptation options in the area. In summary, it was revealed by communities during data collection sessions that land and the forest are the leading livelihood assets in The North Nguu Mountains. A change in production and productivity of land and the forest resources has negative impact on livelihoods and the options for adaptation in the area thus accelerated food insecurity and income poverty amongst communities who depend on the forest for their living in the area.

Pressure on land with no remedial measures results in changing production and productivity of the land resource affecting also the quantity and quality of the farm products hence the entire farm product linked livelihoods. This in turn accelerates prevalence of food insecurity and triggers income poverty amongst communities living in the area. Land degradation influences intensive and extensive grazing and livestock movement (the nomadic agro-pastoral system) in search of water and pasture. If not managed properly, cattle tracks create erosive points that accelerate erosion hence degradation of grazing fields and eventually, declining production and

productivity of the nomadic agro-pastoral systems hence food insecurity and income poverty amongst communities in the area.

The end-points of climate change results in mostly destruction of infrastructural facilities such as communication infrastructures e.g. rural roads, market points and or places, health centres and schools (buildings) that are the software connecting devices for the operational functions of livelihoods and adaptation options. The baseline for the accelerating impact of climate change on livelihoods in the North Nguu Mountains is rooted from vulnerability of the livelihood assets that influence sustainability of the respective livelihood strategies and adaptation options.

6.5 Challenges From the Impact of Climate Change on Livelihoods

This study revealed a number of technical, socio-economic and environmental challenges that are linked to adaptation to climate change in the area. The study enquired about people's knowledge on the challenges that they face when trying to adapt to climate change. Challenges that were linked to the forest or other natural resources. Information from this study revealed that communities expressed the challenges to be emanating from within and outside their living circles especially from political influence and economic imbalances within and outside the localities. The challenges that were mentioned included insufficient capital assets; insufficient policies; insufficient technology adaptations; poor land tenure and land use systems; poor livestock management systems; poor crop farming systems; poor forest management systems; frequent changing weather conditions and massive loss of bio-mass and vegetation cover. Table 6.4 presents the challenges the challenges.

Table 6. 5: Challenges on livelihoods and adaptations

No.	Challenges on livelihood strategies	No.	%
1.	Insufficient capital assets	274	21.9
2.	Insufficient policies	56	4.5
3.	Insufficient technology adaptations	195	15.6
4.	Poor land tenure and land use systems	147	22.3
5.	Poor livestock management systems	89	7.1
6.	Poor crop farming systems	85	6.7
7.	Poor forest management systems	122	9.8
8.	Frequent changing weather conditions	55	4.4
9.	Massive loss of bio-mass and vegetation cover	96	7.7
Total		1,250	100.0

Source: Field data (2012)

6.5.1 Poor land tenure and land use systems

Generally, as revealed in earlier stages of this study, land is the basic livelihood asset in The North Nguu Mountains. With loose ownership and unsustainable land use practices due to the accelerating and long lasting changing weather conditions, production and productivity of the land resource leads to unsustainable livelihoods and options for adaptation thus more challenges for communities in the area. A total number of respondents equivalent to 22.3% of the study sample who responded to the questionnaire considered poor land tenure and land use systems to be a challenge in sustaining livelihoods.

Text box 6.29 presents information from a livestock keeper on poor land tenure in Kilindi village.

> '... in a situation that I'm not owning the land but can only use it ... it means I own it on temporary terms ... for this therefore, it is extremely difficult for me to invest by any means on that piece of land ... the only thing I can do is to make use of it to the maximum ... get all the benefits that I can as quickly as possible before and then walk to find another piece of land somewhere else ... ' (A farmer: Kilindi village, 2011)

Text Box 6. 29: Poor land tenure in Kilindi district.

Source: Field Data (2012)

6.5.2 Insufficient capital assets

A total number of respondents equivalent to 21.9% of the study sample considered insufficient capital as the root challenges on livelihoods and options for adaptation in The North Nguu Mountains. Text box 6.30 presents information from a community member from Kwediboma village on access to capital and the livelihood assets.

> ' ... it is difficult to manage living in this area if you don't own land ... you need capital if you want to make living out of the forest ... the same apply if you want to make living out of land and any other initiative... it is therefore necessary to have capital if you're to make living in this area ... the problem starts with poor access and ability to invest on land ... on utilizing the forest and on trading ... lack of capital ... food insecurity and low income ... ' (A farmer: Kwediboma village, 2011)

Text Box 6. 25: Access to capital and the livelihood assets.

Source: Field Data (2012)

6.5.3 Insufficient technology adaptations

A total number of respondents equivalent to 15.6% of the study sample who responded to the questionnaire considered insufficient technology adaptations to be a challenge on livelihood strategies and making decisions on the options for adaptation in The North Nguu Mountains. Text box 6.31 presents information on education and or knowledge is a livelihood asset from an elder from Kilindi village during group discussions sessions in the village.

> '... the growing number of children who don't have not only the indigenous and or traditional, but also even the conventional know how from modern schools on land including the forest and water management practices ... when they grow up, they will actually be a liability for themselves ... for the community (society) ... and the country ... ' (A farmer: Kilindi village, 2011)

Text Box 6. 26: Knowledge base a livelihood asset

Source: Field Data (2012)

6.5.4 Traditions, culture, norms and values of the people

It was revealed during discussions in this study that various challenges on livelihoods and adaptations in The North Nguu Mountains are resulting from traditions, culture, norms and values of the local communities in the area. The nomadic agro-pastoral communities, for example, are often accused for overstocking beyond the carrying capacity without attaching proper and effective agronomic and veterinary packages.

However, it was revealed during this study that the norms and values of the people under the nomadic agro-pastoral systems for example, compel them to keep different categories of animals in the herd for many purposes. They keep large numbers of livestock for various reasons e.g. specific animals in the herd belonging to specific individuals in the families and or households. Information reveals further that the herd size therefore fluctuates in response to different user rights and ownership. It becomes difficult therefore not only to manage against disaster risks but even to rank wealth from just the herd size.

Text box 6.32 presents information on wealth, climate change and livelihoods as expressed by a key informant from Kilindi village.

> '... the type and number of livestock that a person or a family owns in our society is the key scope to judge wealth for the person or family ... however, based on our culture wealth is not just livestock ... wealth is strongly correlated with the type of livestock that a person or family owns ... the important aspect of livestock for example lies on its value when substituting lower value livestock such as chicken and other small ruminants ... for higher value livestock such as cattle, goats or sheep ... '(A farmer: Kilindi village, 2011)

Text Box 6. 27: Wealth, climate change and livelihoods

Source: Field Data (2012)

Based on some traditions, culture, norms and values of the *Masai*, for example, apart from the difficulty to judge the potential for living on cattle, it was also difficult to judge for the potential for adapting to climate change for them. However, communities expressed the short term mitigation measures such as reducing the number of meals, as well as, working for food or money during hunger periods to be common for adapting to climate change. A common challenge particularly for the agro-pastorals as expressed during this study was on the grazing patterns of both cattle and goats. The challenge is based on woody shrubs and bushes that are very important for browsers such as goats. It was observed that keeping bushes and shrubs in the pasture lands was very important for the livestock keepers. However, other livestock keepers comments that if the bushes and shrubs are left to overgrow and become too thick, then they again suppress growth of underneath grasses that are suitable for the cattle. So some livestock keepers balance the growth of grass and bushes by use of fire in order to have all the animals fed.

6.5.5 Other challenges

The other challenges on managing livelihoods in the area as observed during interview and the number of respondents (percentages) in bracket include poor forest

management systems (9.8%), loss of bio-mass and vegetation cover (7.7%), poor livestock management systems (7.1%), poor crop farming systems (6.7%), insufficient policies (4.5%) and the frequently changing weather conditions (4.4%).

6.6 Summary

By referring to various comments by individuals in the study sample, development and sustainable maintenance of the hardware and software infrastructural support to livelihoods such as transport, buildings and even education (knowledge building) for effective manpower are frequently becoming victims of or vulnerable to climate change and disaster risks. The findings on the impact of climate change on livelihoods indicate that the environmental chains that include provisions of goods and services from the forest ecosystem are the main livelihood assets that are negatively affected by climate change in The North Nguu Mountains.

Findings in this section correspond to information revealed in a study by Reid (2004) on ‘Climate Change, Biodiversity and Livelihood Impacts’ pointing out that any impact that climate change has on land and the biodiversity will threaten livelihoods, food intake and health of poor. However, general findings from this study are analogous to information from UNEP (2005) that the world’s poor depend critically on healthy ecosystems for their livelihoods Collier (2008) also clarifies that the enormous effects of climate change on the African continent are compounded by the greater vulnerability of its economy (e.g. tourism, crop production and livestock keeping) to climatic variation. Empirical case studies indicate more benefits from regular supply of goods and services from the biological diversity and ecosystems

that in turn provide sustainable livelihoods. A study by Gordana (2009) carried in Europe, Asia and Latin America indicates that degradation of the natural resources had impact on location specific livelihoods.

CHAPTER SEVEN
7.0 OPTIONS FOR ADAPTATION TO CLIMATE CHANGE IN THE NORTH NGUU MOUNTAINS

7.1 Introduction

This chapter presents the results and discussions regarding people's awareness on the solutions to the impact of climate change on their livelihood systems within their localities. It presents also the way people perceive and adapt to the most appropriate options for adaptation in their localities. Information in this chapter is presented in three sections: section one presents the reasons for adaptations; section two presents the existing options for adaptation that are presented in two sub sections; sub section one presenting managing the forest potential and sub section two presenting the general options for adaptation. Section three of this chapter presents field survey data on adaptation. This section is again presenting data in two sub-sections where sub-section one presents investments for adaptation from within and sub-section two presents investments for adaptation from outside the area.

Generally, information from this chapter defines the available means and resources that are perceived by people in the area as the most appropriate and effective options for adaptation. The information is necessary as baseline for generating and documenting information on the existing options for adaptation on climate change in gradient to the forest resource and livelihoods in The North Nguu Mountains as provided in objective number three of this study. Moreover, information from this chapter is an input to the main objective of the study that lies on generating

information on the impact of climate change on the rural forest linked livelihoods in The North Nguu Mountains.

7.2 The Reasons for Adaptation

As mentioned earlier when discussing livelihoods and the factors that attracted people to settle in The North Nguu Mountains, land and the forest were mentioned to be the major livelihood assets in the area (Chapter 4). When discussing the mostly affected livelihood strategies or systems by climate change, crop farming, livestock keeping, hunting and collection of the non-timber forest products including specific bits and pieces from game as presented in Chapter 6 Section 6.3 and also Section 6.4 were mentioned to be the main livelihood strategies that were mostly affected by climate change in the area.

Nevertheless, during discussions and ranking, communities revealed that almost all the livelihood assets including the livelihood systems and or structures that they employ for their daily living in their localities are all vulnerable and hence susceptible to the damaging effects of climate change in the area. When mentioning the vulnerable livelihoods by priority, communities in two study villages (Kilindi and Lulago) agreed easily that the most vulnerable livelihood strategies in their villages are crop farming followed by livestock keeping especially under the agro-pastoral systems. Communities in the other two villages of Kwediboma and Gombero had a difficult time to agree on the most vulnerable livelihood in their respective villages.

More information on vulnerability of livelihoods in the study area through discussions and consultations amongst communities in all the study villages indicate

that generally, all livelihood assets and thus all the livelihood strategies in the area are vulnerable to climate change. Generally, unlike trading, collection from the forest and hunting, discussions that took long before come to consensus in all the villages were those discussions involving crop farming and livestock keeping including livestock keeping under the agro-pastoral systems.

7.2.1 Crop farming

Communities in all villages agreed that crop farming is the most vulnerable livelihood strategy to climate change in the area. More information indicates that vulnerability of crop farming to climate change is mainly rooted from the changing production and productivity of the land resource attributed to by changing weather conditions particularly rainfall pattern and rainfall size. Detailed information indicate that temperature including storm patterns and size over time were other main variables that communities mentioned during discussions to also attribute to vulnerability of crop farming in the area.

7.2.2 Livestock keeping

This study reveals that mobile land use practices (particularly the agro-pastoral livestock keeping systems) was the root cause for vulnerability to livestock keeping related livelihoods in the area. The variable that was mentioned by communities that attribute to vulnerability of the pastoral cattle keeping livelihood systems in The North Nguu Mountains was rooted from availability of water and fodder from changing weather conditions over time that affects production and productivity of the land resource particularly vegetation growth for fodder and availability of water for livestock and the livestock keepers.

7.2.3 Hunting

The variable that was discussed and agreed by communities that attribute to vulnerability of the hunting process as a livelihood strategy is rooted from migration of game for water and pasture. Communities indicated to have experienced factors that necessitate migration of game in the area to include also destruction of the forest (game habitat) by communities mostly for adaptation options in their respective localities within the area.

7.2.4 Collection from the forest

Communities discussed and agreed that the frequently long term changing weather conditions together with the multiple land use patterns in the area contributes to the root causes of forest destruction and declining forest health. This was agreed to further be affecting health of the forest leading to a further decline in production and productivity of the forest resource. All these contribute to vulnerability of the forest resource and thus the forest products and services to climate change. Communities were also considering the forest as habitat for game when discussing collection of specific game bits and pieces from the forest in the area. Communities claim further that the frequently changing weather conditions together with changing land use patterns in the area both accelerate degradation of land and the forest resources due to pressure on land and the forest for adaptation. Generally, vulnerability of the forest therefore was revealed to impact on collection of specific bits and pieces from game and the non-timber forest products within the area.

7.2.5 Trading

Information from detailed interview and discussions revealed trading to be equally vulnerable to climate change as the other livelihood strategies in the area.

Communities agreed further that trading operates by linking communities living on crop farming, livestock keeping, collection from the forest, as well as, those who do hunting for their living to access income to supplement their living systems in adapting to climate change. Communities agreed also the vulnerability of trading is rooted mainly from production and productivity of the other livelihood strategies that produce the local trading products in the area.

During discussion in Kwediboma village, a member from the trading community in the village claimed that trading gets high in the village when there is enough goods to be traded and it gets low when there is not enough goods to be traded. It was generally agreed during discussions that, since land and the forest resources in the village are vulnerable to climate change, then production of goods and services for trading (apart from the industrial merchandise) becomes unsustainable. A trader made a comment on petty trading, profit making and livelihoods when conducting this study in Kwediboma village. Text box 7.1 presents comments from the trader.

> ‘ ... we normally make super profit when trading if we have permanent supply of the necessary quantity and quality of the trading products it time and at the right destination ... but since we sometimes don’t get the right quantity and quality of farm crop and livestock products at desired time and destination ... trading becomes a problem and is of no support to us and our families ... we cannot trade even the industrial merchandise because the customers do not have enough income for buying the products from our markets ... ’ (A farmer: Kwediboma village, 2011)

Text box 7. 1: Petty trading, profit making and livelihoods

Source: Field Data (2012)

Information generated through consultations, interview and discussions with communities particularly the key informants as presented in this section embodies

adaptation in the social, economic and environmental stresses from the impact of climate change in the area.

Figure 7.1 presents data from questionnaire interview indicating the main livelihoods that are vulnerable to climate change in the area.

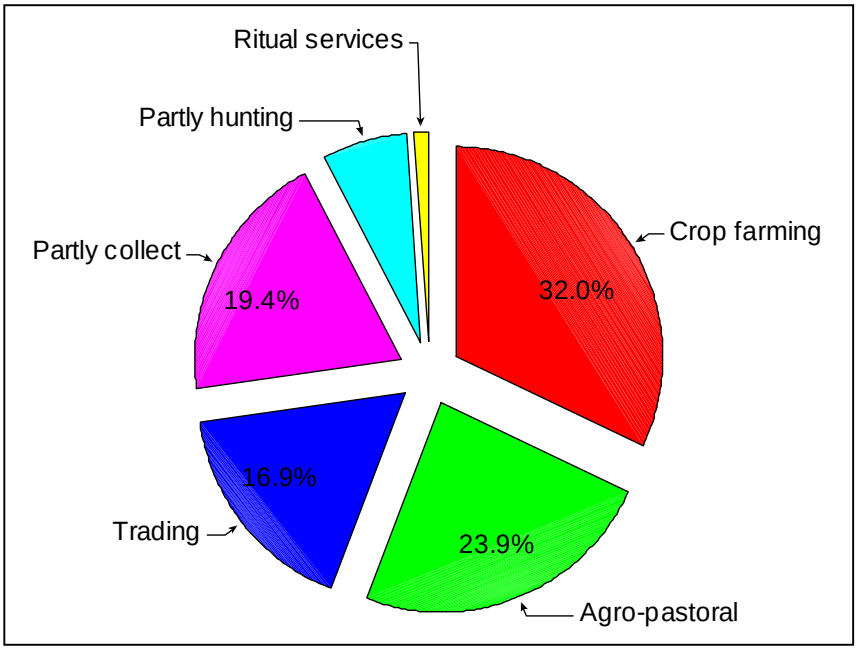

Figure 7. 1: Livelihoods that are vulnerable to climate change in The North Nguu Mountains

Source: Field Data (2012)

All members of the study sample responded to the question that inquired their understanding on vulnerable livelihoods to climate change in their localities. Apart from information from detailed interview and discussions with communities on vulnerability of livelihoods to climate change in the area during this study as indicated before, communities during questionnaire interview observed also that crop

farming to be the lead vulnerable livelihood to climate change in the area followed by livestock keeping and trading. The collection of specific bits and pieces from game and the non-timber forest products from the forest was ranked moderately vulnerable to climate change livelihood whereas, hunting was ranked the minimal vulnerable livelihood from climate change in the area. Trading is among the higher ranked vulnerable strategies together with crop farming and livestock products as it is the main strategy for income generation to supplement the other livelihoods whenever necessary.

7.3 Existing Potential for Adaptation

Table 7.1 presents potential of the forest for livelihoods in the North Nguu Mountains as perceived by communities in the area.

Table 7. 1: Potential of the forest on livelihoods

No.	Forest potential	No.	%
1.	No potential	0	0
2.	Tourism and recreation potential	91	7.9
3.	Ritual / traditional services and functions	13	1.1
4.	Expansion/opening new crop fields and grazing lands	344	30.1
5.	Water source	182	16.0
6.	Forest moisture and manure	127	11.1
7.	Timber and Non-Timber forest products	169	14.8
8.	Habitat for game and bee	131	11.5
9.	Learning events (study visits)	84	7.5
		1,141	100.0

Source: Field Data (2012)

Communities discussed actions and or processes that they perceive to be solutions to the impact of climate change on their living systems in their respective localities.

However, as revealed before during this study, despite the forest being under critical pressure from climate change and livelihoods, still communities considered the forest resource to be potential for livelihoods in the area.

7.3.1 The forest potential

A total of 91.3% of the respondents on potential of the forest for people's daily living agreed that the forest offers potential for tourism and recreation; ritual services and functions; expansion and opening of new crop farms and grazing fields; water source; provision of forest moisture and manure for crop farming and grazing; provision of timber and Non-Timber forest products; habitat for game and bee, as well as, room for learning events in the area. No single members of the community indicated the forest to have no potential or support on livelihoods. Figure 7.2 and 7.3 present the mountain top forests in the North Nguu Mountains.

Figure 7. 2: The Nguu Mountain Forest Reserve in Gombero village

Source: Field Data (2012)

Figure 7. 3: The Nguu Mountain Forest Reserve in Lulago village

Source: Field Data (2012)

a). Provision of room for new crop farms and grazing fields

A total of 30.1% of the respondents considered the forest to provide room for expansion or opening new crop and grazing fields. Information from discussions on the forest potential in Kwediboma village indicate that people are aware of the vastness of the forest resource in communal / public land and they perceive it as a loose land that could be put into a different use. Communities both the local people including the newcomers are therefore opening and expanding their crop farm and grazing fields at the expense of the forest in the area.

A key informant from Kilindi village gave an example during discussions on potential of the forest during this study in the village that in year 2009, the village

hosted two in-migrants who stayed in the village for sometimes, staying in the village hosted by the family of the key informer. The in-migrants cleared four acres of the forest for a crop. Before they got settled properly in the 2010, a livestock from a neighbouring village forced in a cattle track close to the visitor's newly opened crop farm. The visitors decided to squeeze in more into the forest so as to get the crop farms out of contact and destruction of farm crops by cattle. The key informant noted that this was possible because all the villagers including the village government are of the understanding that extra land could always be accessed from the communal forests on the public land.

b). Provision of water sources

A total of 16% of the respondents considered the forest as being a potential and sustainable source of water for livelihoods in the area. A key informer from Gombero village made a comment during in-depth interview and discussions that the mountain-top forest in Gombero village is potential for provision of moisture and water for livestock and crop farming. The key informer continued saying that there are water tributaries and water channels that convey water from water springs on the mountain-top forests. There are people engage in supplementary traditional irrigation practices. Communities observed that generally, the mountain-top forests in the area are of paramount potential as water sources providing maximum multipurpose water use opportunities for livelihoods in the village.

c). Provision of timber and non-timber forest products

About 16% of the respondents considered provision of timber and the non-timber forest products from the forest in support to people's daily living as a unique

potential of the forest resource for livelihoods in the area. Communities discussed with interest the livelihood support from the forest. Despite of the livelihood strategy, every community member admitted during discussions to be getting support for living from the forest. One elder from Lulago village for example made a comment as presented in Text box 7.2

> ‘ ... my husband harvest timber for sale and making furniture for home use. I always collect firewood including wild vegetables, fruits, berries and nuts from the forest for our own use and for selling ... we’re making our living from the forest ... ’ (A farmer: Lulago village, 2011)

Text box 7. 2: The forest, an opportunity

Source: Field Data (2012

d). Provision of habitat for game and bee

A total of 11.5% of the respondents considered habitat for game to be a forest potential that support living in the area. Also, a key informant from Gombero village agreed during interview that game products and honey are the most profitable products for trading in the area. The forest provides habitat for game and bee. The key informer revealed to be engaged in collecting from the forest and bee hunting for trading. The key informer declared therefore to depend on the forest for living.

e). Provision of forest moisture and compost manure

A total of 11.1% of the respondents considered provision of moisture and manure from the forest as support for crop farming and natural pastures for grazing to be among the potentials of the forest in the area. A key informer revealed that it rains, the fertile organic forest soil and forest moisture drains down providing life by

enriching the downstream land for the multipurpose livelihoods strategies in the area. Text box 7.3 presents forest moisture and compost manure as the driving tools for crop farming to a farmer in Kilindi village.

> ‘ ... wind stores moisture from the mountain top forest in my farm ... when it rains, the surface runoff from the forest restores and enrich the soil by compost manure from the mountain top forests and the fertile organic forest soil ... I also enjoy good pasture for my cattle and two goats adjacent to my farm... ’
> (A farmer: Kilindi village, 2011)

Text box 7. 3: The forest, an opportunity

Source: Field Data (2012

f). Others

The other potentials of the forest as mentioned and discussed by communities during data collection for this study include potential for tourism and recreation (7.9%), potential for ritual services and functions 1.1%, as well as, potential for learning events 7.5%. The other benefit of the forest that was mentioned during interview is the forest potential for generating temporary employment opportunities for communities in the area.

The village secretary in Kwediboma for example said the recreation and study teams that include researchers from higher learning institutions, environmentalists and the forest ecosystem professionals, as well as, anthropologists who make part of their field studies in the area create temporary employment opportunities to people especially the youths in the village.

According to village chairman, recently, ritual ceremonies and traditional services and functions have recorded very little or insignificant account on potential of the

forest for people's living in the area as it used to be before. Analogous to information on potential of the forest from interview, community members discussed during focus group discussion sessions in all the study villages their experiences on the forest support to livelihoods and options for adaptations.

Summary of the discussions by communities on potential of the forest for living in The North Nguu Mountains reveal that supply of non-timber forest products was agreed to be the higher ranked forest potential for people in the area. The other potentials of the forest that were discussed and agreed are all emerging from goods and services from the forest ecosystem that include timber and water supply functions of the forest. The other functions of the forest that were discussed but ranked low in support for living in The North Nguu Mountains include habitat for game and hence support for hunting and employment opportunities.

7.3.2 Maintaining the forest potential

Generally, information from communities indicate that sustainable management of the forest is the only strategy for maintaining the forest potential in the area. However, most of the mountain-top forests in the area are protected by the government as 'Catchment Forest Reserves'. However, the hangover from the conventional forest management approaches that are still backed by policies and regulations and embraced by the central and local governments restrain access to and hence poor management of the catchment value of protected forests.

Table 7.2 presents summary responses on forest protection in the area that generally focused on the contemporary measures propagated by the government and the other

stakeholders of the forest in the area including the indigenous forest management systems managed by the local people in their respective localities.

Table 7. 2: Ways to sustain the forest potential.

No.	**Ways to sustain the forest potential**	**No**	**%**
1.	Develop Village Forest Management Plans	283	22.6
2.	Abide to existing forest regulation and enforcement	124	9.9
3.	Use of indigenous know-how on forest management	225	18.0
4.	Scale up and out the forest management strategies	177	14.2
5.	Develop village, household and or individual forests	331	26.5
6.	Capacity building on Village Land Use Planning	110	8.8
Total		**1,250**	**100.0**

Source: Field Data (2012)

In the framework of the forest being fundamental as a livelihood asset in the area, communities were inquired more during this study to elaborate on how best the forest potential can be managed for it to continue support livelihoods in the area. All members of the study sample responded to the inquiry on ways to sustain the forest potential. Despite a full pack of ideas and suggestions, information indicate that the main forest management measures to be adopted and maintained include to develop village forest management plans and to abide to the existing forest regulation and enforcement. Others include use of indigenous know-how and systems on forest management; scaling up and out forest management strategies; to develop village, household and or individual forests, as well as, to conduct capacity building to communities on conventional programmes on sustainable adaptations from potentials of the forest resource in the area.

The forest management measures or strategies that were proposed by communities during this study include:

a). To develop village or individual forests

A total of 26.5% of the respondents to the questionnaire interview considered developing communal, household and or individual forests in the villages would be the most effective way of sustaining the forest potential for livelihoods in the area. The baseline for this idea as expressed by communities during discussions was to have forests that communities can access and manage easily. During discussions, an ordinary community member who was a member of the study sample from Kilindi village stressed mainly on establishment of woodlots as presented in Text box 7.4

> ‘ ... fetching firewood from the government’s forests is risky ... It’ll be more economic and cost effective to protect my own forest for my own use ... I think the direct benefits of forest protection efforts are at present serving more the needs of the other stakeholders of the forest including those who do not actually have interest in sustaining the forest ... ’ (A farmer: Kilindi village, 2011)

Text box 7. 4: The forest, an opportunity

Source: Field Data (2012

b). To develop and put into operation village forest management plans

A total of 22.6% of the respondents considered developing and putting into operation village forest management plans. Communities considered and agreed that developing and putting into operation village forest management plans will be an ideal, effective and sustainable way for managing forests that fall in village and or communal lands. A key respondent from Lulago village supported the collaborative forest management concept as presented in Text box 7.5.

‘ ... the government should consider supporting us based on the resources that we have in our village ... our needs towards the forest should therefore be considered as we also have a role in managing the forest ’ (A farmer: Lulago village, 2011)

Text box 7. 5: Protecting the forest

Source: Field Data (2012

c). Use of indigenous know-how on forest management

A total of 18% of the respondents considered use of indigenous know-how on forest management to be an effective way of sustaining the forest and the forest potential. During discussions, a key respondent from Gombero village stressed use of indigenous know how in managing the forest to be introduced in the structure of the newly introduced collaborative forest management systems.

Text box 7.6 presents the comment as narrated by the farmer.

‘...as we can all see strength and quality of the traditional ‘*minenge’* forests that existed for centuries now ... our grand fathers did it partly for ritual services ... including other tangible benefits ... some of the forests are still existing in good health ... it’s something that we can try ... so that rainfall will stabilize again like it was in the past ... ’ (A farmer: Gombero village, 2012)

Text box 7. 6: Indigenous know how in managing the forest

Source: Field Data (2012

The other ways of sustaining the forest potential as revealed by communities during questionnaire interview and the respective percentage of respondents in brackets include scaling up and out of the forest management strategies to benefit more communities (14.2%); abiding to existing forest regulation and enforcement (9.9%), and to conduct capacity building to communities village land use planning (8.8%).

Generally, although very few individuals (only 8.8% of the study sample) mentioned the concept of land use planning, but communities discussed with a very clear notion and agreed on a Village Land Use Plan to be a sustainable tool for managing the natural resource base of the village including the forest. Communities discussed and agreed that if communities (the land users) participate fully and abide to the rules and regulations agreed upon during the village land use planning process, then forest destruction will be minimized and potential of the forest and the other resources to support livelihoods will be sustained. However, a few more community members continued appraising the conventional forest management strategies and systems while advocating more on the collaborative arrangements based on some social cultural innovations that are linked to managing the forest. Information indicated further that forest management was core in protecting the environment while keeping the social-economic requirements including sustainable livelihoods in the area. This study revealed also that the forest is very supportive to livelihoods in The North Nguu Mountains Table 7.3 presents analysis summary of the forest potential on livelihood in the North Nguu Mountains through the Strength, Weaknesses, Opportunities and Threat – SWOT approach.

Table 7. 3: Status of the forest in SWOT

THE FOREST	
STRENGTH	A livelihood asset.
WEAKNESSES	Management constrain livelihoods.
OPPORTUNITIES	Ecosystem goods and services.
THREATS	Climate change accelerating factor.

Source: Field Data (2012)

Generally, this study reveals that climate change have impact of the general living of the people in The North Nguu Mountains in socio-economic, ecological and environmental, as well as, demand and supply perspectives.

7.3.3 The general options for adaptation

All members of the study sample in all the study villages responded to the inquiry on their knowledge on the options for adaptation to the impact of climate change in their respective localities. The agreed options by communities include intermix of crop farming and livestock keeping; collection of specific bits and pieces from game and the non-timber forest products; migration; indigenous farming systems and livestock management; hunting; use of underground water, as well as, borrowing. Table 7.4 presents the general options for adaptation in The North Nguu Mountains.

Table 7. 4: The general options for adaptation

No.	The common adaptation options	No.	%
1.	Intermix of crop farming and livestock keeping	586	46.9
2.	Collection of the non-timber forest products	373	29.8
3.	Migration and resettlement	89	7.1
4.	Indigenous farming systems and livestock management	43	3.4
5.	Hunting	97	7.8
6.	Use of underground water	32	2.6
7.	Borrowing	30	2.4
Total		1,250	100.0

Source: Field Data (2012)

a). Intermix of crop farming and livestock keeping

A total of 46.9% of the study sample considered intermix of crop farming and livestock keeping to be a more reliable and effective option for adaptation. Text box 7.7 presents information from a farmer while discussing the issue in Kilindi village.

> ‘ ... we normally get food and a little income from maize and beans from our crop fields ... but also from a little livestock (numbered) that we keep we’re glad we can afford at least a meal ...’ (A farmer: Kilindi village, 2012)

Text box 7. 7: Intermix of crop farming and livestock keeping

Source: Field Data (2012

b). Collection of the non-timber forest products

A number equivalent to 29.8% of respondents to the questionnaire interview considered collection of specific bits and pieces from game and the non-timber forest products to be an option for adaptation to climate change for individuals, families and or households in the area. Despite being mentioned before as a full livelihood strategy by some communities in the same area, still other people within the same area think of or spared such processes as options for adaptation. One key informer said during interview that there are people who make their living by collecting specific bits and pieces from game and the non-timber forest products both for consumption and trading. But when the situation of collecting from the forest gets worse or does not fetch them enough for living, then such people extend the collection horizons to collecting wood and the non-wood raw materials for making pots, mats, baskets and other non-timber and non-wood handcrafts again for home use and trading to enable them afford buying food.

c). Hunting

A total of 7.8% of the respondents to the questionnaire interview considered hunting as an option for adaptation during difficult weather conditions. A community member during discussions in Kilindi village made a comment that people who depend much on hunting do always collaborate with people who are involved in collecting specific bits and pieces from game and the non-timber forest products inside the forests. The collaboration is mainly for the hunters to show the collectors where exactly to collect bits and pieces from game.

The community member added that hunters always make some good income in the village. However, another community member admitted during the discussions that temporarily, the hunters are for sometimes during the seasons shifting to collection of the non-timber forest products from the forest. The community member elaborated more by saying that hunters go around the forest more extensively during hunting spotting game bits and pieces for collection. They thus know what is available, how much, when and where in the forest.

7.3.4 Other options

As presented in Table 7.3 the other options for adaptation as mentioned, discussed and agreed by communities during data collection for this study with the number of respondents from questionnaire interview in bracket include migration and resettlements (7.1%) where communities keep on moving from one place to the other within and outside the area (seasonal migration) sometimes with livestock herds for the agro-pastorals. The other option for adaptation that was mentioned, discussed and

agreed upon when conducting this study was managing the indigenous farming systems and livestock keeping (3.4%) i.e. application of the indigenous know-how (systems) in crop farming and livestock keeping.

When requested to explain the indigenous farming systems that the farmer was using during bad weather, the farmer ended mentioning local application of shifting cultivation and fallowing. The farmer tries to push the techniques to adaptation options within the crop farming livelihood. Communities mentioned also during discussions measures like traditional intercropping, expansion of farm size, planting of drought tolerant crops and application of rotational fallow systems practices to be means of adapting to climate change in their respective localities.

The indigenous livestock management systems and processes that were discussed include application of traditional livestock management systems like splitting cattle herds during drought for grazing and water, traditional management of pasture lands like keeping grazing fields for calves and sick livestock, as well as increasing or decreasing size of the livestock herds during difficult times.

It was further noted during discussions on the options for adaptation that a few more individuals, families and households engage in using underground water i.e. digging shallow wells for domestic use, watering livestock and irrigation (2.6%). A few more individuals, families and or households use to borrow from friends and neighbours (2.4%). One respondent said during discussions that some borrow and invest in preparing sugarcane jiggery (local brew) for selling until when the difficult period with the weather conditions is over.

During discussions with the nomadic livestock keepers at Mtego in Gombero village, a traditional leader explained how cattle keeping communities manage land cover (including the forest) to stabilize adaptation. Text box 7.8 presents information adaptation in Gombero village.

> ‘ … we move with part of our cattle looking for pasture and water … not all … we keep a mixture of livestock in the herd … we normally manage pasture land by using standing biomass (hay) for dry season feed and … we also control access to fodder and water through herd splitting … we use controlled forest fires as a pasture management tool in specific areas and for specific periods of time … ’ (A farmer: Gombero village, 2012)

Text box 7. 8: Mitigation and adaptation for the local community

Source: Field Data (2012

7.4 Investments for Adaptation

Apart from investing for livelihood diversification, information from this study, particular information from detailed discussions with key informers during and after the data collection sessions reveal further that some people invested in processes and systems to support them make a living during prolonged bad weather and changing climatic conditions only.Communities discussed and agreed that such kind of investments and related activities are very active during bad weather conditions or changing climatic conditions. Before, communities did not take in such practices but they are now strongly involved in the actions because of the changing weather conditions. Communities agreed therefore that such investments are area specific options for adaptation. Among the investments that were mentioned by communities include some local and area specific systems for preparing and selling chewing tobacco, as well as, use of sugarcane to prepare jiggery (local brew) for own use and sell some for income generation. The other investments for adaptation in the area

include investing in processing units including wood and non-wood handcrafts; cattle keepers particularly the agro-pastoral cattle keepers keeping the right balance between the size of the herds and the number of people the herds has to support; use of energy saving technologies particularly on fuelwood; use of bricks (sand and or cement) instead of wooden poles; establishment of individual woodlots, as well as, establishment of teams for fighting forest fires mainly deployed and owned by the respective formal and informal local authorities, community organizations and livelihood groups such as farmers or the livestock keepers.

7.4.1 Investments from within

This study observed also some practices in form of structures, systems and processes that are maintained by individuals, groups and or families / households as options for adaptation in the area. Note that the practices and the respective structures, systems and processes are directly linked to the forest and their effectiveness and usefulness (utility value) surpasses in terms of effectiveness and sustainability the other options that are not linked to the forest in the area. Nevertheless, all the observed investments have been grouped into strategies that are temporarily adapted to shield the impact of climate change on livelihoods in the area.

Some of the observed investments were owned by communities in the villages but some were owned by people from outside the area. Some of the investments were managed for home consumption but most were managed for business (making profit from trading). The investments that were managed for adaptation to climate change within The North Nguu Mountains were as presented in Table 7.5

Table 7.5: Investments for adaptation in The North Nguu Mountains

STRATEGY	BENEFITS	STATUS		OWNERSHIP		
		Existing	Operational	Individual	Family	Group
Investments in tree nurseries	Wood, fruits	13	13 *(100%)*	9 69.2%	1 7.7%	3 23.1%
Investments in surface water	Irrigated farming	11	10 *(90.9%)*	2 20%	1 10%	7 70%
Investments in underground water	Shallow wells	27	25 *(92.6%)*	11 44%	5 20%	9 36%
Investments in managing the forest	Grass, wood	5	5 *(100%)*	3 60%	1 20%	1 20%
Investments in poultry and small ruminants	Food and income	18	18 *(100%)*	13 72.2%	2 11.1%	3 16.7%
Investments in Land Use Planning	Sustainable land uses	4	4 100%	0 0%	0 0%	4 100%
Investments in open market centres	Petty trading	6	6 *(100%)*	0 0%	0 0%	6* 100%
Investments in processing plants (manufacturing and value addition).	Timber sales	52	51 *(98%)*	31 60.8%	7 13.7%	13 25.5%
	Carpentry wood-works	72	68 *(94.4%)*	42 61.7%	11 16.2%	15 22.1%
	Decorations mats/baskets	25	25 *(100%)*	11 44%	5 20%	9 36%
	Mud bricks plants	14	14 *(100%)*	6 42.8%	2 14.3%	6 42.8%
	Mud / wood utensils	9	5 *(55.5%)*	3 60%	1 20%	1 20%
	Charcoal plants	8	8 *(100%)*	5 62.5%	1 12.5%	2 25%
	Local brew (jiggery)	34	34 *(100%)*	21 61.7%	7 20.6%	6 17.6%

* - village council / communal owned.

Source: Field Data (2012)

a). Investments in tree nurseries

The only problem observed during the survey is for the investments sponsored by people from outside the area if can be sustainable as options for adaptation. However, during bad weather conditions the investments are used by the insiders as options for adaptation. The investments sere as options of adaptation but at the same time provide employment to communities in the respective villages. Apart from creating employment, the investments serve as local economic development opportunities in the area. Figure 7.4 presents the observed tree nursery structures.

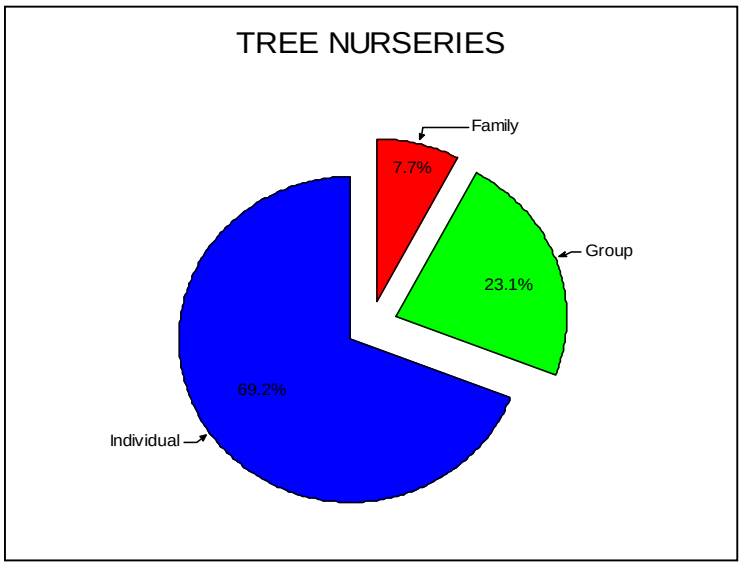

Figure 7. 4: Investments in tree nurseries in The North Nguu Mountains
Source: Field Data (2012)

Of all the observed tree nursery investments in all the study villages, 69.2% were managed by individuals, 23.1% by groups and 7.7% by families. Investments in establishing and running of tree nurseries (multi-purpose tree nurseries i.e. timber, fruit, shelter and fuel wood including ornamental trees species) were observed to mostly be managed by individuals and were growing enterprises. As revealed during

discussions including the formal and informal interviews, adapting to climate change, as well as, sustaining the forest potential requires people to engage in sustainable management of the forest. The process of managing the forest always starts with establishment and management of tree nurseries. However, observations on the tree nursery venture in the study area indicated that the primary objective or motive force behind most of the individuals, families and or groups to establish and run tree nurseries was to generate income. People who establish and manage tree nurseries expect people including the government and other stakeholders of the forest at various levels to engage in tree planting for woodlots, as well as, tree planting in general as a kind of land and or forest management.

b). Investments in surface water

Figure 7.5 presents ownership of investments in surface water.

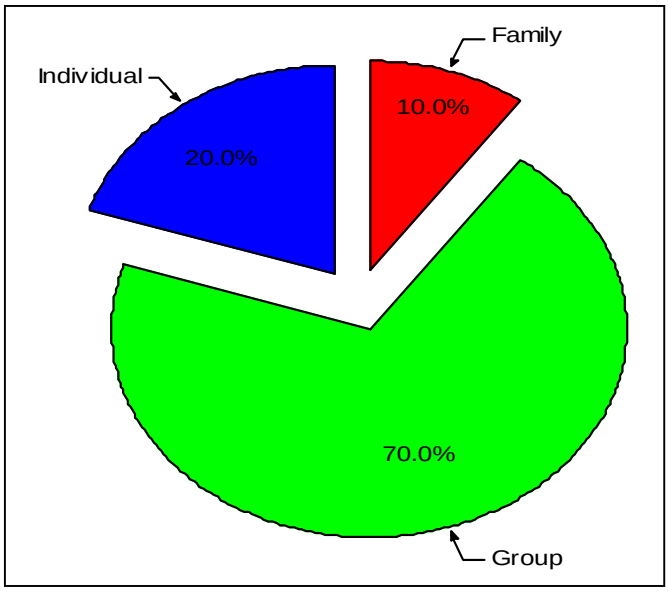

Figure 7. 5**: Ownership of investments in surface water in The North Nguu Mountains**

Source: Field Data (2012)

Communities (mostly groups) who invest in managing surface water are mainly doing it for supplying water for domestic use, irrigation farming and watering livestock. Others make it as a business enterprise and mostly sell water to people for domestic and other uses including food selling and local alcohol ventures. Of all the observed surface water investments, 20% were managed by individuals, 70% by groups and 10% by families. Investments in establishing and running of surface water structures is mostly managed by groups particularly water user groups formed by individuals or families for irrigated crop farming and livestock keeping, as well as, domestic water use including selling water to people that are engaging in selling cooked food and local alcohol.

As revealed by communities during discussions including the formal and informal interview sessions when conducting this study, water is essential as a livelihood asset in The North Nguu Mountain. Rainfall is the main source of water in the area and it is highly influenced by the long term frequent changing weather conditions in the area. Availability of water for people's living requires, therefore, people to engage in managing surface water structures in a sustainable manner i.e. sustainable surface water structures such as surface water harvesting structures, surface water drainage structures, as well as, surface water storage structures. But efficient and sustained performance of such structures will also depend on sustainable management of the water harvesting, water storage and water drainage systems such as land use and land cover potential for the climatological and hydrological drainage systems in the area. Nevertheless, the observed primary objective of surface water ventures in the study area i.e. the motive force behind managing sustainable surface water structures is for

sustaining production and productivity in crop farming livestock keeping and trading for individuals, families and or groups for food and income security in the area. Those who have established and are now managing surface water structures envisage that individuals, families and groups including the government and other stakeholders of the livelihoods at various levels will support endeavors in surface water use structures for livelihoods and adaptation options in the area.

c). Investments in underground water

Figure 7.6 presents ownership and patterns of structure and system investments of underground water in The North Nguu Mountains.

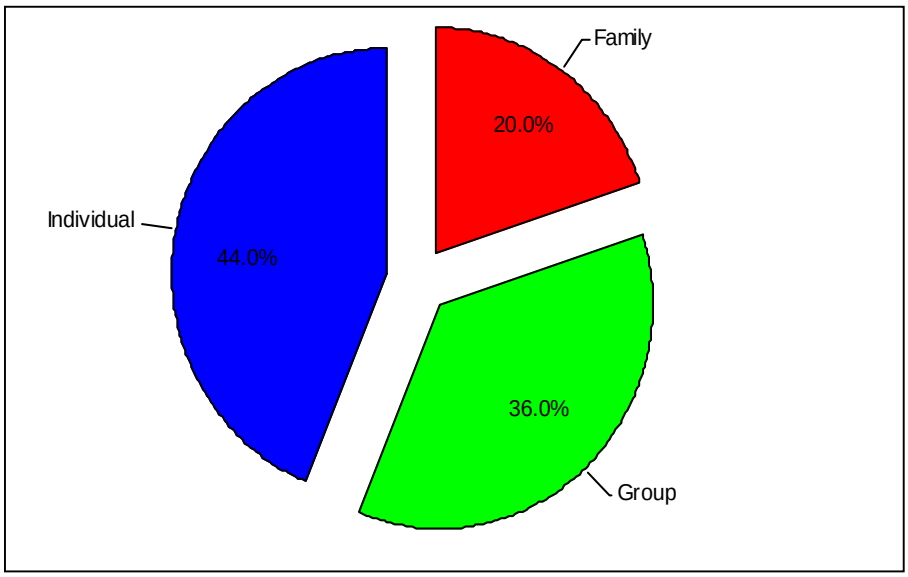

Figure 7. 6: Ownership of investments in underground water in The North Nguu Mountains

Source: Field Data (2012)

Due to water shortage for living i.e., water for supplementary irrigation farming, water for watering livestock and water for domestic use, communities are investing in exploiting underground water to support living in the area. It was also observed

that investments in underground water are largely managed as business entities for selling water to communities who put it into multi-purpose uses such as gardening, cooking food and preparing local alcohol for sale in the area.

Of all the observed surface water investments, 44% were managed by individuals, 36% by groups and 20% by families. Investments in establishing and running of underground water (small entity structures) is mostly run by individuals particularly water users for irrigated crop farming and watering livestock. A big portion of the entities are managed for domestic water use where some sell water business men and women that are engaged in selling cooked food and local alcohol. As revealed by communities during discussions including the formal and informal interviews, low supply of surface water in The North Nguu Mountains is supplemented by exploiting underground water in the area.

As it was observed when assessing surface water investments, underground water requires also people to invest in managing underground water. This also means that sustainable water availability in the area will always depend on investments in the establishment and management of underground water structures connected to surface water harvesting structures, surface water drainage structures, as well as, surface water storage structures with sustainable management of the water ways and the water drainage systems in the area. The observed primary objective of underground water ventures in the study area i.e. the motive force behind investing for underground water is to enable communities i.e. individuals, families, households and or groups acquire sustainable water supply for farm crops (supplementary

irrigation), watering livestock and water to attend other livelihoods requirements so as to ensure food and income security in the area. Communities envisage that stakeholders of the livelihood endeavors will put priority in supporting underground water investments for livelihoods in the area.

d). Employment opportunities in managing the forest

Despite establishment and management of tree nurseries being connected into forest management, some youths and adults both men and women get employed seasonally to maintain (planting and re-planting) boundaries of the catchment forest reserves surrounding their villages. The employment opportunities for the youth and adults were before organized by the Forest and Beekeeping Division – FBD under the Ministry of Natural Resources and Tourism in the country.

The same employment opportunities were during this study being managed by the Tanzania Forest Service (TFS), a semi-autonomous government executive agency which provides legal structures and frameworks for managing forests and bee resources in the country. Such employment opportunities were also managed seasonally through the district and their respective village governments. The employment opportunities for the youth and adults apply also to community forest reserves that are managed through the district council including also village forest reserves that are managed by communities through their respective village governments. Through the temporary employments, communities benefit from the ‘cut and carry’ of grass, as well as, loose wood for developing wood products from inside the forests mostly done by individuals, families and or groups. Figure 7.7

presents results of the observed community participation in managing the forest resource in their respective villages.

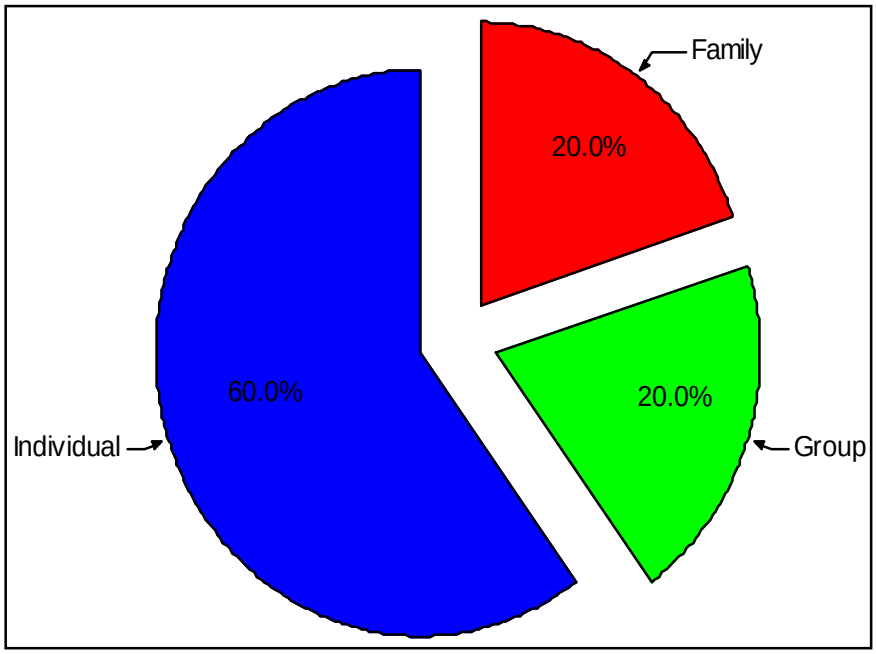

Figure 7. 7: Employment opportunities in managing the forest in The North Nguu Mountains

Source: Field Data (2012)

Of all the observed employment opportunities in managing the forest, 60% of the employees were individuals, 20% by groups and 20% family members in family groups. Employment opportunities for managing the forest was observed to be accessed more by individual youths and adults where peoples organized into communal or family groups have equal but lower chances.

As revealed by communities during discussions including the formal and informal interviews, the forest particularly forest management, provided formal and informal employment opportunities in The North Nguu Mountains. Such employment

opportunities come from the various stakeholders of the forest resource in the area including communities themselves, the other stakeholders of the forest resource in the area including the government and visitors to the forest for various reasons. This is supplemented by communities themselves who want to clear or plant forests for various reasons. As it was observed when assessing investments in establishing tree nurseries, forest management requires also people to invest in forging strong ties with the government at local and national levels for being connected to structures and systems that provide policy and legal support.

The observed primary objective of the need for individuals, groups and families to be employed in the study area i.e. the motive force behind being employed in managing the forest is to enable communities i.e. individuals, families, households and or groups acquire income to buy food when in food shortage and also to ensure income security. Communities envisage that stakeholders of the forest including the government will put priority in supporting endeavours in forest management so as to sustain livelihoods in the area.

e). Investments in poultry and small ruminants

It was observed that a few community members in The North Nguu Mountains do invest in poultry and small ruminants. Such investments were in the past meant for supplementing food supply in big villages (trade centres like Kwediboma and Gombero), but as of late, such endeavors have gained popularity in the business enterprise window even in the suburb areas. It was evidently clear during the house to house observation survey that poultry and small ruminants remains as a food and

income support entity to mainly employees such as school teachers, forests, community development, health including the agriculture and livestock field extension officers). The ordinary communities in the villages invest in poultry and small ruminants in a very small scale. It was observed that the venture required an intensive veterinary drugs and services for successful poultry and small ruminant's endeavors. Figure 7.8 presents categories of communities that are involved in the poultry and small ruminant's undertakings in The North Nguu Mountains.

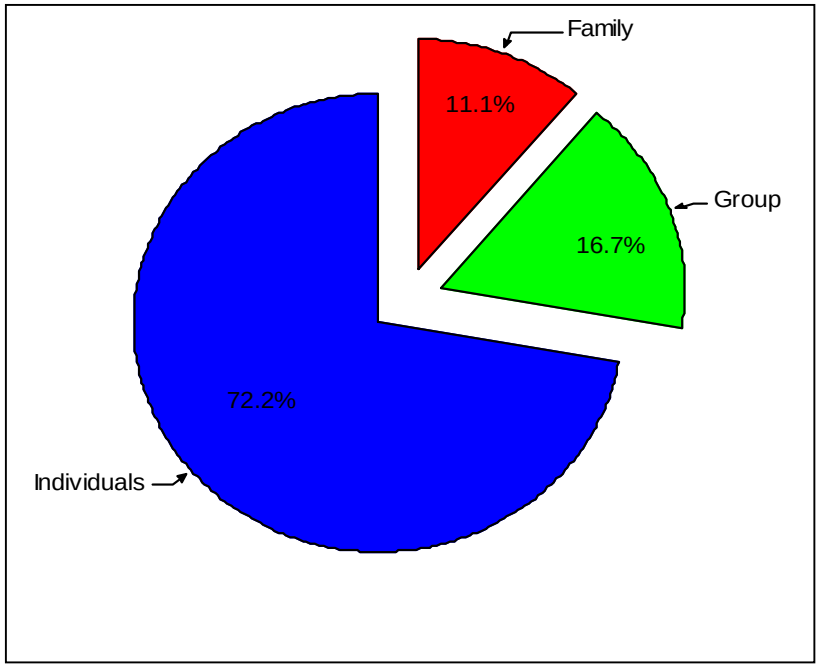

Figure 7. **8: Investments in poultry and small ruminants in The North Nguu Mountains**

Source: Field Data (2012)

Of all the observed investments in poultry and small ruminants' enterprises in the study area, 72.2% of the investors were individuals, 16.7% were in groups and 11.1% were invested by families or in family groups. Investments in poultry and

small ruminant's enterprises were seen more to individuals followed by groups and a small portion of family entities. As revealed by communities during discussions including the formal and informal interviews, investments in poultry and small ruminant's enterprises provided employment opportunities in the area. The observed primary objective of the need for investing in poultry and small ruminants was to enable communities i.e. individuals, families, households and or groups acquire income to buy food when in food shortage and also to ensure income security. Communities envisage that poultry and small ruminant's products can easily and cost-effectively bridge the gap for sustaining livelihoods in the area.

f). Investments in open market centres

It was observed that the District Council (Kilindi District Council – KDC) and village governments have invested in the weekly open markets in a few specific villages. Such markets operate always once or twice a week. The main processes in open market centres is managing petty trading where people from within and outside the respective villages sell and buy goods and services for livelihoods and or adaptation. The common products available in such open markets include a mixture of farm products such as dry and green maize (cereals), dry and green beans, banana, vegetables and livestock products.

Other products in the village open markets include game and non-timber forest products, wooden utensils and some wood and mud decorations including bits and pieces from game. Figures 7.9 and 7.10 present weekly village open market operations in The North Nguu Mountains.

Figure 7. 9: Food selling in the open market day - Kilindi village.

Source: Field Data (2012)

Figure 7. 10: Selling banana in the open market day in Lulago village

Source: Field Data (2012)

Normally open markets are used as weekly shopping centres with a variety of general homestead merchandise. No individuals or families or households that invest into

operating the open markets because such enterprises are used as source of revenue for the District Council, as well as, the respective village governments where the open markets operate. Nevertheless, the investment serves as an option for adaptation to most communities because, in case of bad weather conditions or no support for living, the open market centres are the only places where communities can always negotiate their living by selling or buying.

g). Investments in processing plants

The study observed also investments in various processing plants run mainly as enterprises by communities in the study area. Investments in the various processing plants were seen more to individuals followed by groups and some by families. As revealed by communities during discussions including the formal and informal interviews especially when making interviews or discussing on the petty trading issue, communities particularly the trading communities pointed out the value addition aspect to various crop farming and livestock products including the game and non-timber products before selling. The observed primary objective of the need for processing various products was to enable the products acquire more value and hence more income during selling.

Communities particularly those who engage in business particularly the tradesman had the notion that processing timber before selling add value to timber hence fetches more (higher prices) in the markets. This notion is aligned with the notion that communities acquire more income to buy food and also to ensure income security hence sustaining livelihoods. Timber processing investments mainly for timber products that were observed during the study include:

i). Timber processing plants

Figure 7.11 presents ownership of timber collection, processing and selling.

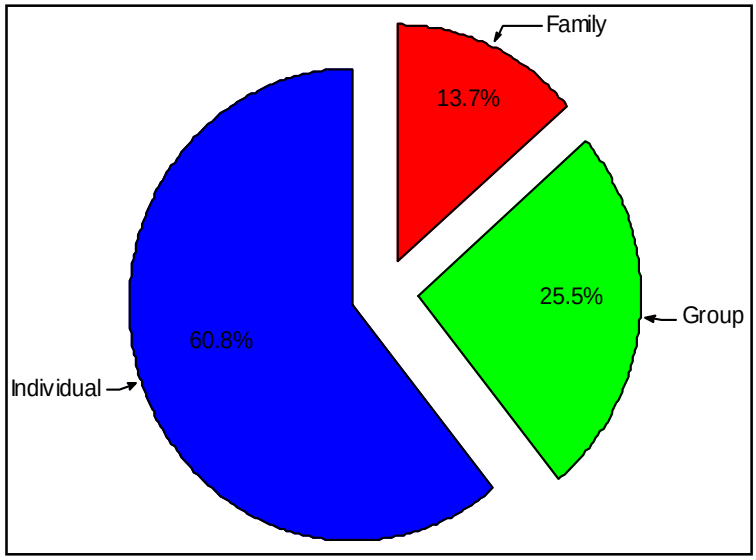

Figure 7.11 Timber collections, processing and selling
Source: Field Data (2012)

Of all the observed investments in processing plants, 60.8% of the investors in timber processing plants were individuals, 25.5% were owned by groups and 13.7% of the plants were owned by families. Sale of timber both locally processed and even timber processed by using modern tools is done mostly by individuals who first process timber selling license (permits) from the relevant authorities at the District Forest Office through the respective village governments.

ii).Carpentry and wood works plants

Of all the observed investments in carpentry and woodworks, 61.7% of the carpentry and wood working plants were owned by individuals, 22.1% were owned by groups and 16.2% were invested by families. Carpentry and woodworks plants goes

analogous to timber processing and timber sale plants. Figure 7.12 presents ownership of carpentry and wood work plants in The North Nguu Mountains.

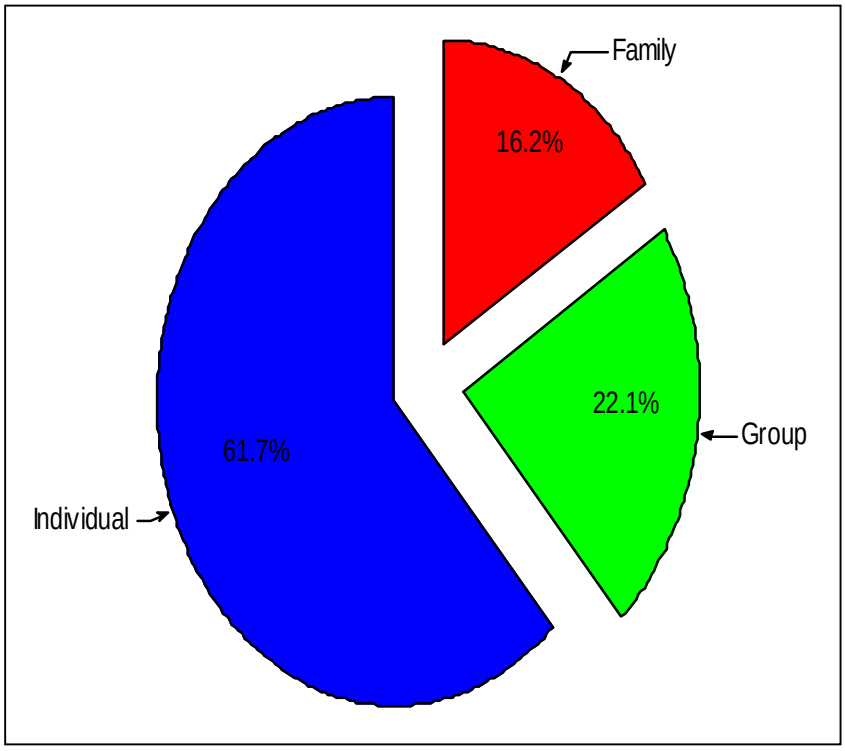

Figure 7.12 1 Ownership of carpentry and wood works plants
Source: Field Data (2012)

iii). Decorations (mats, baskets) processing units

Of all the observed investments in processing units for decorations and other hand crafts, 44% of all the handcrafts and decorations processing units were owned by individuals, whereas 20% were owned by groups and 36% were invested by families. Though undertaken as an income generating enterprise dominated mainly by women, handcrafts from the non-timber and wood products is one of the forest linked enterprises in The North Nguu Mountains. Figure 7.13 presents ownership categories of the community in managing handcraft enterprises.

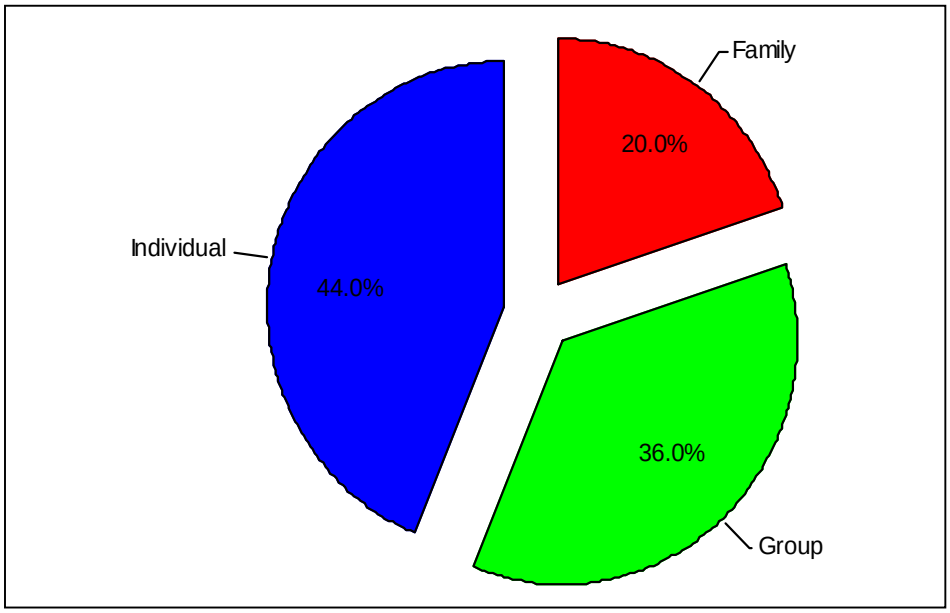

Figure 7.13: Ownership of decoration (mats and baskets) plants in The North Nguu Mountains

Source: Field Data (2012)

iv). Mud bricks plants

Of all the observed investments in mud brick, 42.8% of the investors in mud bricks processing plants were owned by individuals and it was observed that the same number of community members own similar investments in groups. It was further observed that 14.3% of the mud brick plants were owned by families. It was observed that preparation of mud brick is a fast growing enterprise with high demand both in big villages (small towns) like Kwediboma and Gombero in the study area. Mud bricks fetch also high demand in villages where most people want lasting longer, strong and modern houses. Figure 7.14 presents ownership of enterprises and management of mud brick plants while Figure 7.15 and 7.16 present mud brick plants in The North Nguu Mountains.

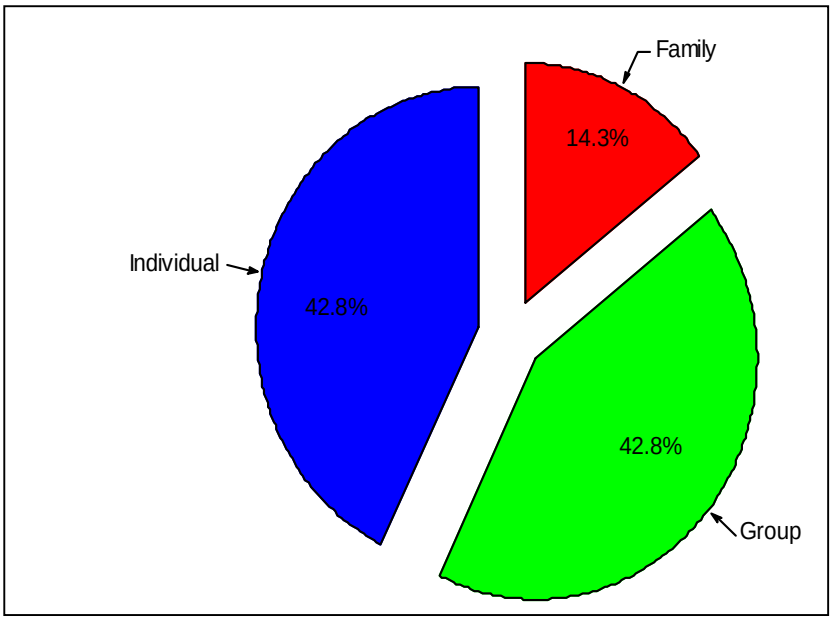

Figure 7. 14: Ownership of mud bricks plants in The North Nguu Mountains

Source: Field Data (2012)

During formal and informal interviews and discussions during data collection, communities revealed that tree harvesting for house construction (trees for construction poles) was among the main forest degrading factors in the area. Use of mud bricks for house construction was considered an effective remedial measure or option. Preparing mud bricks has been observed to be dominated by individuals particularly youths organized in groups.

However, government through the relevant district sectoral lines and the village governments encourages and sometimes support management of the mud brick plants in villages that are within the vicinity of protected forests. This is because undertakings on managing and manufacturing mud bricks are within the forest

protection strategies as an incentive to reduce demand for wood poles for house construction from the forests.

Figure 7. 15: A mud brick plant in Lulago village

Source: Field Data (2012)

Managing mud bricks plants is a challenging investment as it also requires fuel for burning the mud bricks. The only cost effective, reliable and readily available fuel for the mud bricks plants is fuel wood. However, fetching enough fuel wood for existing plants for mud bricks is also considered as a challenge.

Figure 7. 16: Mud bricks ready for sale in Kilindi village

Source: Field Data (2012)

v). Mud and wooden utensils plants

Of all the observed investments in mud and wooden utensils plants, 60% of the mud bricks processing plants were owned by individuals and it was further observed that 20% of such investments were owned by groups whereas, the other 20% were owned by families. Dominated mostly by the women, mud and wooden utensils processing plants in The North Nguu Mountains are normally forest based enterprises because the processors have to fetch raw materials for processing the utensils from the forest. Figure 7.17 presents ownership of plants for mud and wooden utensils.

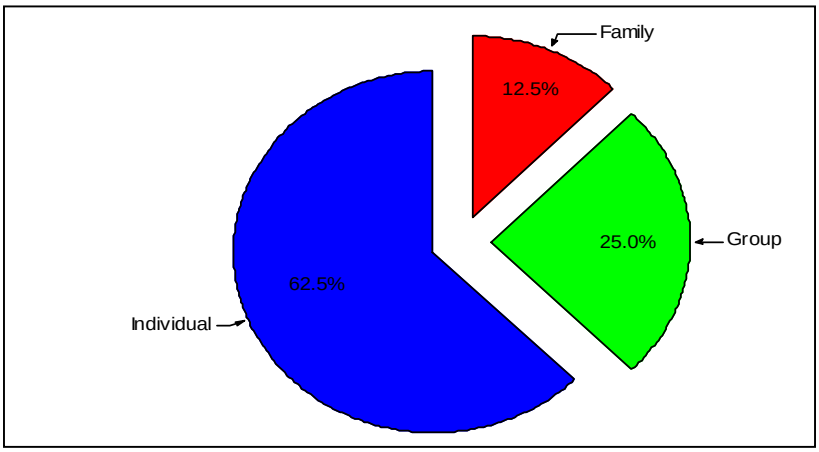

Figure 7.17 1 Ownership of mud / wood utensils plants
Source: Field Data (2012)

vi). Charcoal plants

Of all the surveyed mud and wooden utensils plants, 62.5% of the mud bricks processing plants were owned by individuals and it was observed that 25% of the investment were owned by groups whereas, the other 12.5% of the mud and wooden utensils were owned by families. Figure 7.18 presents ownership of charcoal plants.

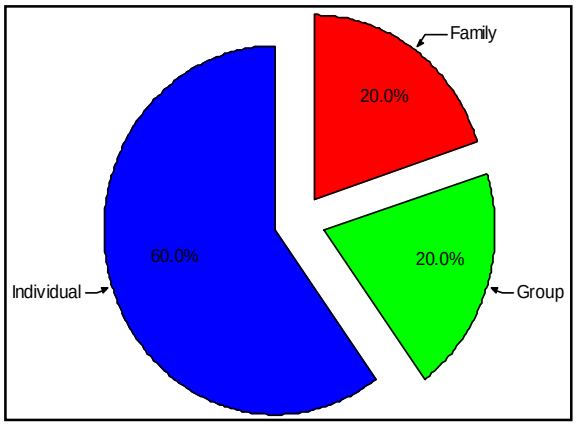

Figure 7.18: Ownership of charcoal plants in The North Nguu Mountains
Source: Field Data (2012)

Charcoal that is referred to in this study is a light black residue consisting of carbon and some remaining ash obtained by removing water and other volatile constituents by heating of wood in the absence of oxygen. This type of charcoal is the second major source of domestic fuel in all the family homes of the extension officers including food vendors throughout the study villages and the entire North Nguu Mountains. A very low number of the ordinary local community use charcoal as fuel wood in the villages. Instead, most of the charcoal prepared in the villages is transported to big towns and business centres where demand for charcoal is very high for both domestic use, as well as, food vendors related enterprises. It was observed also that plants for preparing charcoal are mainly livelihood or adaptation processes focused at for profit making to supplement income (purchasing power) of the villagers on food and other social needs such as school and medical fees.

vii). Local brew – jiggery

Figure 7.19 presents ownership of plants for local brew– jiggery.

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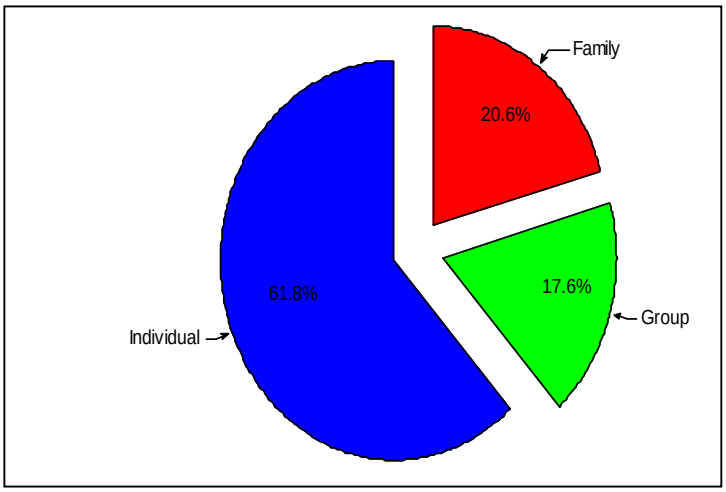

Figure 7. 19: Ownership of plants for local brew - jiggery

Source: Field Data (2012)

A total of 61.8% of the investors in local brew processing units were individuals and it was observed further that 25% of the local brew refinery plants were owned by groups whereas, the other 12.5% of the local brew plants were owned by families. Local brew in The North Nguu Mountains is mainly made of cereals (particularly maize and millet), bee-honey and in a few places sugar cane (if available). Dominated by individuals and particularly the women, although discouraged by religious institutions in the area, preparations and selling of local brew is mainly managed as a source of income for supporting family needs e.g. buying food and settling school and medical bills.

viii). Village level Land Use Planning

Despite only 8.8% of the study sample highlighting land use planning at village level (Table 7.5) majority of the communities that were involved in this study acknowledged that they hold land under deemed right of occupancy experiencing frequent land and water use conflicts, deforestation, land and environmental degradation. According to the communities, this has led to low land productivity hence food insecurity, low income and poor local economic growth.

Communities indicate that the village land use planning process is of great importance for sustainable livelihoods in the area. One respondent in an informal interview said that the land use planning concept was introduced in the mid 1990's in the area under a donor funded project, the Handeni Integrated Agroforestry Project – HIAP. The action was structured in an integrated structure of land, water and forest management in the context of land use planning at village level.

The whole process was owned by all the land users through their village government. Areas for the agreed land uses were also managed by the respective land use individuals and or groups under the village government as the patron. Processes to implement land use planning at village level varied depending on the geographical size of the villages the were to be intervened, ecological factors, as well as, the socio-economic conditions of the people in the respective localities. Communities agreed in common that parallel to environmental conservation, the village land use planning supported smallholder land users particularly the crop farmers and livestock keepers in designing, adopting and managing land, water and the forest products and services at the optimal level and so accelerate food security, sustainable income and poverty reduction in the area.

Generally, just from observations done by the researcher during this study, there were reasonable investments in adaptations to climate change by communities and some supported by the government through the district and village governments. The type and nature of the investments in adapting to climate change indicates kind and the structure of the livelihood assets and the options for adaptation in the study area. However, there were no external support for mitigation that were observed in the area during this study.

7.4.2 Investments from outside the area

Investments from outside the vicinity of The North Nguu Mountains were in this study seen as livelihoods or efforts adaptation options that are linked to a focus on mitigation from external support. Such investments as observed in the area include:

a). Investments in improved settlement schemes

The country's villagization processes in the early seventy's moved people from their native indigenous scattered clan based homesteads into communal settlements (villages). This move created concentration of people in specific areas. It was revealed through story telling in formal and informal interviews including formal and informal discussions during the study that this particular practice was and is still practiced in in other areas within the North Nguu Mountains. Examples were drawn particularly from Kilindi and Lulago villages where clans or families were still confining themselves in specific micro clan based vicinities that were getting overpopulated over time by other people coming in through social interactions like marriage, as well as, other visitors and the normal in-migrants settling in the localities for livelihoods or options for adaptation. Such trends create pressure on resources for livelihood or options for adaptation in the areas. So the country's villagization processes in the early seventy's solved to some extent this problem by moving people from their native indigenous scattered clan based homesteads into communal settlements (villages) drawn from the socialist based structures and ideologies rooted from communist development strategies.

b). Investments in resettlements and sustainable land use systems

With exception of the nomadic agro-pastoral communities that keep moving in and out of The North Nguu Mountains with their cattle herds in search of water and pasture, out migration in the area is insignificant. Prolonged changing weather conditions that signify climate change remains key for the nomadic agro-pastoral land users to determine when to move and where to go for pasture and water.

However, this trend is increasingly becoming more complex given pressure from government regulations such as compulsory education for children and health services for mothers and children. Moreover, there is also a slowly growing process of the village level land use planning concept that minimizes also mobile land uses. Meanwhile, the increasing mixture of livestock keeping with crop farming together as a livelihood diversification for adaptation limits also mobile land uses.

c). Investments in common property regimes and reciprocal arrangements

Quantity and quality of pasture for example in the North Nguu Mountains is very high characterized by the density of vegetation cover, the mix of trees and grasses, as well as, species growth patterns in the area. However, due to the diminishing trends of the forest and water in the area, such resources are managed through common property regimes where access to pasture (free grazing land) and water for livestock are negotiated depending on reciprocal arrangements.

Nevertheless, there are local traditional grazing / range lands that are used during the drier periods as alternative pasture-lands for the agro-pastoral communities in the area. Management of such areas was organized locally under indigenous systems / knowhow where utilization zones (particularly for grazing and fuel wood purposes) were drawn up. Simple forest / range land use rules (forest / range land utilization procedures) were developed and patrolling systems put in place. Everything was secured by a set of traditional norms and values. Often, such arrangements got interrupted by same community members and sometimes by new comers (immigrants) and could no longer get practiced successfully.

d). Investments in the gender aspect and entrepreneurship

This study reveals that women involvement in owning livestock and the livestock market chain is very narrow in the agro-pastoral communities. Women were engaged in processing milk, animal fat, ghee, blood, hides and skin for home use only. However, as of recent, there is a very gradual move towards women owning their own cattle and trading in the market place, although the women do not actually come to the markets but use a male representative. There is also some primary livestock product processing for trading by women such as ghee, but this is done at a very small scale. They are furthermore determined to study the feasibility economic gain for undertaking drying of raw hides and skins for local markets. Nevertheless, women economic groups are with remarkable success in the area. They engage in trading and manage their business affairs very well. They make use of modern services such as banking systems.

Moreover, savings among the women has increased and among those involved in the economic groups, there are clear indicators of improved livelihoods and access to income i.e. ready cash when in need (for example, for medical or school needs). Generally women were during this study seen mostly as entrepreneurs and were willing to take on business challenges. Some examples on women entrepreneurship enterprises that were emerging with mitigation linked support in the area include:

i). Umoja Women Group

The Umoja women group Kwediboma village for example has embarked on vegetable gardening, selling vegetable to communities in the village centre and nearby settlements.

ii). The Mchali Women Group

The Mchali Women Group in Lulago village has established a cereal bank, encouraging women in the village to keep maize for commercial purpose, and have joined hands with the youth (male) group for bigger economic projects.

iii). The Parakuyo Women Group

The Parakuyo Women Group from Gombero village runs a handcraft project making bead jewelry and sale in the village and nearby village weekly open markets, as well as, to visitors in the village.

iv). The Seuta Women Group

The Seuta Women Group in Kilindi village is dealing with handcrafts from the non-wood forest products. The group is exploring further for new ventures such as honey production and marketing, as well as, a possibility of extending their trading routes to big markets in nearby big trading centres.

e). Investments in absolute processes

Communities have during this study indicated clearly their thinking that the government and the other stakeholders of the forest resource consider them to be the destructive agents of the forest resource. However, in the process, they have indicated also that the government officials and the business community are the main destruction processes of the forest resource in the area. But previous information in this study indicate that the forest provides room for hunting including bee hunting, as well as, collection of game and the non-timber forest products for livelihoods and the options for adaptation.

7.5 Summary

The findings on the common options for adaptation from this study include the observed investments for such as additional land clearing to meet basic household food security needs. This results in a typical chain of reactive adaptation such as increasing farm sizes to expand yields. This is further demonstrated in the loss of available water and wood fuel supplies that is paired with impending environmental stresses due to climate change. For this therefore, limitations to agricultural or livestock productivity are not only an impact of climate change in The North Nguu Mountains but they are also reflecting present realities on the options for adaptation that limit livelihoods. Generally information from this study underscores findings that underlines the effects of climate change on natural resources such as land and biodiversity whereas, changes to natural ecosystems affect climate parameters.

With poor support from within and outside their localities for example, communities in The North Nguu Mountains go for hunting and collection from the forest to support their living. However, hunting and collection of specific bits and pieces from game and the non-timber forest products provides livelihoods through supply of raw and semi processed game and the non-timber forest products for consumption and petty trading. Petty trading by itself is through this study already a livelihood strategy in The North Nguu Mountains. Communities therefore keep investing in crop farming, livestock keeping and trading, but also in hunting and collection from the forest as both livelihood strategies and at some occasions, use same processes as options for adaptation depending on the prevailing situation and the weather condition that prevails at that particular time. For this reason therefore, only a few

processes such as the intermix of crop farming and livestock keeping, migration and resettlements, indigenous livestock management and farming systems, use of underground water, as well as, borrowing with a little traditional curative services such as the use of medicinal plants with specific game bits and pieces to livestock and the human remains to be occasional or seasonal options for adaptation that are maintained by communities in the area.

Findings from this study are also analogous to information from a series of research findings from other scholars such as UNEP (2001) and Agrawala, *et al.*, (2003) who informs that by virtue of their importance as habitats, forests are integral to conserving biological diversity and ecosystems with provision of livelihoods. UNEP (1995) informs also that The 1995 Convention on Biological Diversity - CBD in Jakarta, Indonesia, highlighted that forests and forest biological diversity play important economic, social, and cultural roles including habitat for wildlife. FAO (2007) informs also that forests can play a role in adaptation by helping human societies to stabilize resilience capacity in adapting to climate change. However, contents similar to findings from this study are also revealed by Rudolf de Groot *et, al.,* (2002) and Heal, *et al.,* (2004) who informs that ecosystem structures and functions make ecosystem assets that through interaction with the human, produce ecosystem goods and services for livelihoods, economic growth and support to poverty reduction. Literature from The IPPC (2001) indicate further that Tanzania took part in a series of global conferences focused at devising some means of reducing human influence on the climate and to formulate ways of exploiting the climate for social and economic benefits.

Moreover, a number of other researchers that include Walter and Simms (2002); Huq *et al. (*2003); Sperling (2003), as well as, Tyler and Fajbar (2009) reveal that climatic change is dramatically affecting livelihoods for the poor just because such people are often heavily dependent on climate sensitive sectors such as agriculture and livestock while they have limited financial, institutional and human capacity to anticipate and respond to the direct and indirect impacts of climate change. Lessons from the forest in this study denotes information from Larson *et al.* (2007) who indicates clearly that forests also serve as a source of resilience by providing resources to local populations and through forest land scape, design to protect communities from increasingly erratic weather hence contributing to both global and local mitigation portfolios. However, although the focus in this study is on the forest linked livelihoods and climate change, information from this section is generally matching with information from Lovemore Tinarwo in AWF (2003) on game resources linked livelihoods in the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE).

CHAPTER EIGHT
8.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

8.1 Introduction

This chapter presents the summary, conclusions and recommendations of this study. The chapter also puts together the implications of certain issues that arise from the impact of climate change on rural livelihoods before giving out the recommendations based on the information generated from this study.

8.2 Summary

The population for this study was 1,250 people (631F, 619M) from four (4) villages (Kilindi, Kwediboma, Lulago and Gombero) within the North Nguu Mountains in Kilindi district, Tanzania. The study population was a homogeneous group with discreteness alongside livelihood strategies. The sample size for this study consisted of youths, adults and elders both male and female with various levels of formal and informal education. Data was collected by use of questionnaire (in structured and semi structured interviews), formal and in-formal discussions, observations, as well as, use of secondary data (documentary review).

Before assessing people's perceptions on the relationship between climate change and their daily living, this study assessed first people's background in the North Nguu Mountains. The study revealed that the good weather conditions with timely seasonal rainfall, the arable land with the rich forest resource and game to be the

main factors that attracted them to move in and settle in the area. The study revealed also that crop farming, livestock keeping and trading including hunting and collection from the forest were the main livelihoods in the area. It revealed also that the impending weather conditions in the area arises from both natural (specific natural events or features), as well as, the human factor.

This study was also set to examine the influence of climate change on people's daily living. It was revealed that climate change constrains efficiency and effectiveness in the livelihood strategies thus compelling communities to unsustainable livelihoods. The major option for adaptation as revealed in this study was livelihood diversification i.e. communities adopting to contemporary innovations and new initiatives in livelihoods, for example, crop farmers keeping a few livestock in their homesteads whereas, the pastoral livestock keepers cultivate small plots of food crops in areas surrounding their temporary settlements. The study was finally set to evaluate potential of the forest for adapting to climate change. The forest was clearly revealed to be the prime livelihood asset in the area. The prominent option for adaptation in the area was intermix of crop farming and livestock keeping. Although the study aimed to focus on potential of the forest for adaptation, findings revealed clearly that potential of the forest serve as the principal livelihood asset in the area.

8.3 Conclusion

8.3.1 People's perception on climate change and livelihoods

The first objective of this study was set to assess people's perceptions on the relationship between climate change and livelihood systems in the North Nguu

Mountains. The required information for this objective was the way people perceive climate change in relation to their daily living in the area.

But before explaining their perceptions on climate change, the people outlined first potential of the vast arable land and the rich forest resource on it together with the conducive weather conditions including rainfall to be the major reasons or factors for them to settle in The North Nguu Mountains. This study revealed further that both the contemporary (weather broadcasting) and indigenous flora and fauna including the active location specific atmospheric systems to be the early warning systems for climate change in their respective localities.

This study revealed also that communities consider the root causes of climate change in The North Nguu Mountains to be mainly the human factor particularly the livelihood actions that were taken directly on land and the forest. The accelerating long term changing weather conditions that were considered by communities to be climate change in The North Nguu Mountains include changing rainfall pattern and size, changing vegetation cover including the forest, changing temperatures, changing water and salinity levels including changing human and livestock health.

Communities explained also that when lasting longer, the changing weather conditions (climate change) lead further to unsustainable livelihood strategies and or systems including the options for adaptations. This study therefore generated sufficient information on people's perceptions on climate change that affect people's daily living in The North Nguu Mountains.

8.3.2 The influence of climate change on livelihoods

The second objective of this study was set to examine the influence of climate change on people's daily living in the North Nguu Mountains. The required information for this objective was some facts (including figures) on the impact of climate change on livelihoods in The North Nguu Mountains. The study revealed further that the long term changing weather conditions in the area triggers risks and uncertainty on livelihoods in two folds; first, it increases pressure on the forest particularly when people get into the forest directly for the adaptation options.

Pressure on the forest was further revealed to be the factor that accelerate changing of the forest health that in turn, affects production and productivity of the forest. The study revealed also that the accelerated changing weather conditions affects functioning of the ecological systems of the mountain-top forests causing rainfall variability. The study revealed also that the long term changing weather conditions affects supply of the ecological resources for livelihoods. Generally, the impact of climate change was revealed to ruin the livelihood assets, as well as, demolishing functioning of the ecological systems in the area.

Deterioration of the livelihood assets, as well as, demolishing of the functioning of the ecological systems was revealed by communities to result into changing rainfall patterns and size, degradation of land and the forest thus, low production and productivity of land and the forest resources in the area. Communities revealed that this situation results into unsustainable livelihoods that in turn results to low income, food insecurity, income poverty and low economic development in the area. The

study therefore generated successfully sufficient information on the impact of climate change on livelihoods in The North Nguu Mountains as it was planned.

8.3.3 Potential of the forest

The third objective of this study was set to evaluate potential of the forest for adapting to climate change in the North Nguu Mountains. The required information for this objective was information on potential of the forest on the options for adaptation to climate change in The North Nguu Mountains. It was clearly revealed through this study that the forest was the prime livelihood asset providing a variety of livelihood opportunities to communities in the area.

It was revealed through this study that communities invested in the forest linked livelihood strategies including hunting and collecting from the forest for their living. This study revealed further that even the options for adaptation such as the intermix of crop farming and livestock keeping, indigenous livestock management and farming systems including use of underground water were also linked directly to the forest potential in the area. Generally, this study revealed that a livelihood strategy in the area is not sustainable if it damages the forest (a livelihood asset) and increase its vulnerability. The study realized further that utilizing the forest including goods and services from the forest ecosystem in a sustainable manner builds up resilience and transition to sustainable livelihoods with availability, effectiveness and efficiency of the livelihood functions and the option for adaptation from the forest. The specific information that was required for this objective was potential of the forest for adapting to climate change in The North Nguu Mountains. This study therefore,

generated sufficient information on potential of the forest for the options for adaptation. However, despite potential on the options for adaptation, the study revealed further that the forest was the principal livelihood asset in The North Nguu Mountains. This study therefore generated more sufficiently the required information on potential of the forest for adaptation options in The North Nguu Mountains.

8.4 Appraisal of the model used in the conceptual framework

Modified from the comprehensive conceptual model for disaster management as applied by Kelly (1998), the conceptual framework for this study has succeeded in establishing a link between the forest and livelihoods. The study verified that loss of the forest (biodiversity depletion) have influence on land degradation parallel to increased emissions intensifying climate change hence unsustainable livelihoods.

According to this study, the new forms of partnership and profit sharing for forest management as elucidated in this study seem to ignore the needs and interests of local communities living adjacent to the forests. Such a situation breeds more conflicts and disputes among stakeholders of the forest. However, the situation does not hold with the ideas as elucidated by Nelson *et al.*, Eds (1995) on a power and participatory development model. This study has proven that the power and participatory development model is less practical in collaborative actions to fulfil the interests, needs and capacities of all concerned parties. Progress of the community based forest management - CBFM and the joint forest management – JFM arrangements as established in this study show that stakeholder of the forest resource focus on utilization (profit) rather than protection of the resource.

Furthermore, the findings from this study indicate that communities in The North Nguu Mountains manage the forest for a variety of livelihoods including the options for adaptation to climate change. This situation is similar to reviewed literature on climate change and rural livelihoods at global and local levels as built in and managed by ideas from the Power and Participatory Model that establishes a link between the forest (as a livelihood asset) to sustainable livelihoods.

Nevertheless, the study prove that the ecological functioning of the forest i.e. value of the forest (structure and functions) provides potential on rural livelihoods as stated by UNEP (2001) and Agrawala, *et al.,* (2003) who indicate also that by virtue of their importance as habitats, forests are integral to conserving biological diversity and ecosystems with provision of livelihoods. Furthermore, Information from this study is also similar to information from UNEP (1995) on the importance of the forest by The 1995 Convention on Biological Diversity - CBD in Jakarta, Indonesia that highlights forests and the forest biological diversity to be playing important economic, social, and cultural roles including habitat for wildlife.

Also, similar to information from this study, information from FAO (2007) indicate that forests play a role in adaptation to stabilize resilience capacity in adapting to climate change. Studies by Rudolf de Groot *et, al.,* (2002) and Heal, *et al.,* (2004) reveal also that structures and functions of the forest makes the forest ecosystem to produce goods and services for livelihoods as revealed from this study. Nevertheless, Larson *et al.* (2007) indicates clearly as revealed in this study that forests serve as a source of resilience contributing to mitigation portfolios.

8.5 Recommendations

This study revealed that the forest is the key livelihood asset in the North Nguu Mountains. Access to the forest has been revealed to be fundamental for sustainable livelihoods. The study indicates further that land use conflicts from the mobile land use systems accelerates the impact of climate change on livelihoods in the area. The study noted that when shifting cultivation collides with pastoral systems, the agro-pastoralists were always at the losing end mostly because they cannot claim legal ownership of the grazing land. People find it strange that the land laws gives land use rights to crop farmers and not the others.

This study recommends therefore that:

a) The country's land tenure and land use legislations to account for the mobile land use livelihoods systems and strategies.
b) Communities in general to be supported to diversify into new innovations so as to accommodate both temporary and permanent migration for livelihoods.

This study revealed also that the forest in The North Nguu Mountains is a potential source of critical ecosystem services that provide substantial benefits to local livelihoods (a livelihood asset). Loss of the forest influences the environmental, economic and social circles of livelihoods such as low food and fodder supply to the human, livestock and game. However, the study reveals further that most of the rich North Nguu Mountain-top natural forests are protected as Catchment Forest Reserves. According to this study, the collaborative arrangements for managing the forest apply more efficiently and effectively on community or village forests that are located on public lands. This study recommends therefore that:

a) Communities to be supported in developing and managing location specific collaborative structures and systems for managing the forest and the other natural resources base in their localities. For example, the country could revert to the involuntary resettlement policy so as to avoid or minimize physical relocation or resettlements that interrupt development of the natural resources base available in communal lands.
b) Communities to be supported to maintain the cultural and environmental structures with a focus to develop and expand localition specific nature and or culture tourism.

This study revealed further that increasing income is a necessary condition for sustaining livelihoods. It revealed also that an increase in income for rural communities does not guarantee sustained rural livelihoods. For example, it was revealed that income from the forest is often low due to lack of value addition to the forest products (including game products), poor marketing including market information systems. This study recommends therefore that:

a) To develop and conduct tailor made capacity building programs for communities so that they can be able to engage in value addition, quality control, as well as, engaging effectively in marketing and development of market information systems for forest products so that people can be able to maximize profit and increase income from the forest products.
b) Develop and conduct tailor made programs for inclusive and sustainable growth with strong economic multiplier effects to communities so as to trigger local economic development in the area.

Water has been revealed in this study to be crucial for livelihoods. Rainfall was in this study identified to be the main water source in the area with the forest providing the rainfall moderation function in the area. The relationship between the forest and water are fundamental to livelihoods but according to this study, the forest and rainfall are vulnerable to climate change. This study indicate further that the mountain-top natural forest in The North Nguu Mountains have a great impact on the development process at both local and national levels. According to URT (2005), as a micro catchment, the area drains into the Pangani, one of the rich hydrological basins that feeds water resources to communities in northeast Tanzania.

The natural mountain-top forests improve aquifer charge, the hydrological drainage and river catchments that supplies hydroelectric power. According to Mittermeier, *et al* (1998), the rich and unique flora and fauna biodiversity of the spectacular North Nguu Mountain ecosystems forms an important area for ecological sustainability that sustains biodiversity, water resources and environmental flow system livelihoods within and outside The North Nguu Mountains. Climate change therefore have a direct impact on the forest ecology particularly the water resource (through rainfall) and thus livelihoods in the area.

This study recommends therefore that:

a) The government at national and local levels including the other stakeholders of the forest resource in The North Nguu Mountains to support communities manage the ecological potential of the forest in their respective localities.
b) Communities in the area to be exposed and supported in improved smallholder irrigation practices in the light of Land and Water Management.

Based on the focus, set up, area coverage and findings from this study, it is pertinent to consider further studies on climate change, the forest and livelihoods in The North Nguu Mountains. The studies will have to verify the forest potential i.e. the ecological potential of The North Nguu Mountain forests. In this context, scientific research with laboratory tests could be more effective.

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APPENDICES

Annex 1(a)

INTERVIEW QUESTIONNAIRE
(DODOSO LA USAILI)

THE IMPACT OF CLIMATE CHANGE ON FOREST LINKED RURAL LIVELIHOODS: THE CASE OF THE NORTH NGUU MOUNTAIN BLOCK IN KILINDI DISTRICT, TANZANIA

(MADHARA YA MABADILIKO YA TABIA NCHI KWA MAISHA YA VIJIJINI YANAYOTEGEMEA RASILIMALI MISTU HUSUSAN KWA ENEO LA MILIMA YA NGUU KATIKA WILAYA YA KILINDI, TANZANIA)

Before the interview
(Kabla ya mahojiano)

1. Introduce yourself and introduce the objective(s) of the study to the interviewee. Thank him / her for agreeing to be interviewed. *(Jitambulishe, elezea malengo ya utafiti na kumshukuru mhojiwa kwa kukubali kushiriki katika mahojiano)*
2. Encourage the interviewee to ask any questions and reassure him / her that the information will be kept confidential for the intended purpose only. *(Mhamasishe mhojiwa kuuliza asichokielewa na umhakikishie kwamba habari zote atakazotoa zitakuwa ni siri na ni kwa matumizi yaliyokusudiwa tu)*
3. Thank again the interviewee at the end of the interview for cooperating. *(Mshukuru tena mhojiwa kwa kutoa ushirikiano baada ya mahojiano)*

Identification of interviewee – CODE 0
(Utambulisho wa mhojiwa)

Village (code 01) *(Kijiji)*	Gombero	
	Kilindi	
	Kwediboma	
	Lulago	
Respondent No. ……..... *(Mhojiwa Na.)*		
Livelihood (code 02) *(Mfumo wa maisha)*	Crop farming *(Kilimo)*	
	Livesstock keeping under agro-pastoral systems *(Ufugaji)*	
	Other (mention) ***(Jingine / taja)*** **.....**	
Sex (code 03) *(Jinsi)*	Male *(Mume)*	
	Female *(Mke)*	
Age (code 04) *(Umri)*	Young *(Kijana)*	
	Adult *(Mtu wa makamo)*	
	Elder *(Mzee)*	
Education (code 05) *(Elimu)*	None *(hakusoma)*	
	Literacy program *(kisomo cha watu wazima)*	
	Primary education *(elimu ya msingi)*	
	Secondary education *(elimu ya sekondari)*	
	Post secondary education *(elimu zaidi ya sekondari)*	

Date of interview ***(Tarehe ya mahojiano)*****:** _____

Name of Interviewer ***(Jina la aliyehoji)*****:** _____

Q 1. Perception of communities on climate change – CODE A

(uelewa / mtazamo wa jamii juu ya mabadiliko ya tabia nchi)

a). What is climate change *(Mabaddiliko ya tabia nchi ni nini?)* **- code A1.**	1. Changing rainfall (storm patterns and size) *(Mabadiliko ya mvua)*	
	2. Changing temperatures *(Mabadiliko ya viwango vya joto)*	
	3. Changing livelihoods hence income levels (mabadiliko ya maisha / kipato)	
	4. Other (mention) ***mengine (taja)*** **.....**	
b). Causes of changing weather conditions *(Sababu za mabadiliko ya hali ya hewa)* **- code A2.**	1. Pressure on the forest *(msukumo katika matumizi ya misitu)*	
	2. Poverty *(Umaskini)*	
	3. Natural factors *(Sababu za kiasili)*	
	4. Other (mention)) ***mengine (taja)*** **.....**	
c). Early Warning Systems (climate change indication) *(viashiria vya mabadiliko ya tabia nchi)* **- code A3.**	1. Rainfall (storm size) *Mvua (kiwango cha mvua)*	
	2. Drought *(Ukame)*	
	3. Changing temperatures *(Mabadiliko ya viwango vya joto)*	
	4. Other (mention)) ***mengine (taja)*** **.....**	

Q2. The impact of climate change on livelihoods – CODE B

(athari za mabadiliko ya tabia nchi kwa mifumo ya maisha)

a). Earning living (*kujipatia maisha)* **- code B1**	1. Crop farming *(kilimo cha nafaka)*	
	2. Livestock keeping *(ufugaji)*	
	3. Petty trading *(biashara)*	
	4. Other (mention) ***mengine (taja)*** **.....**	
b). Impact of climate change on living *(athari katika kujipatia maisha)* **- code B2**	1. Land Use conflicts *(migogoro ya matumizi ya ardhi)*	
	2. Low production / produc tivity in crop / livestock *(uzalishaji mdogo)*	
	3. Land / forest degradation *(kudhoofika kwa raslimali ardhi na misitu)*	
	4. Other (mention) ***mengine (taja)*** **.....**	
c). Adaptation options (*njia mbadala za maisha)* **- code B3**	1. Collection of the non-timber forest products *(kuokota msituni)*	
	2. Hunting *(kuwinda)*	
	3. Moving to other areas *(kuhamia eneo jingine)*	
	4. Other (Mention) ***mengine (taja)*** **.....**	
d). Challenges on adaptation options *(changamoto za mabadiliko)* **- code B4**	1. Insufficient capital assets *(mtaji mdogo)*	
	2. Insufficient policies *(sera na mipango dhaifu)*	
	3. Insufficient technology adaptation *(mapungufu katika elimu na technologia sahihi)*	
	4. Other (mention) ***mengine (taja)*** **.....**	

Q3. Potential of the forest to rural livelihoods – CODE C

(umuhimu na mchango wa misitu katika maisha ya vijijini)

a). Potential of the forest to living of the people *(umuhimu wa misitu katika maisha ya watu)* **- code C1**	1. No potential *(Haina umuhimu)*	
	2. Potential for tourism and recreation *(utalii na burudani)*	
	3. Study potential *(masomo, tafiti)*	
	4. Other (mention) ***mengine (taja*** **.....**	
b). The impact of climate change on the forest *(madhara ya mabadiliko ya tabia nchi katika misitu)* **- code C2**	1. No impact *(hakuna madhara)*	
	2. Pressure on the forest *(msukumo / msongo katika matumizi ya misitu)*	
	3. Unsustainable forest production/productivity*(uzalishaji dhaifu misitu)*	
	4. Other (mention) ***mengine (taja*** **.....**	
c). How to sustain the forest potential on livelihoods and or adaptation *(kuendeleza umuhimu wa misitu katika maisha au njia mbadala za maisha)* **- code C3**	1. Develop Village Forest Management Plans *(mipango ya kijiji)*	
	2. Abide to existing forest regulation and enforcement *(kutekeleza mipango iliyopo inayofuatwa sasa)*	
	3. Use of indigenous forest management *(fuata mipango ya kiasili ya kuendeleza misitu)*	
	4. Other (mention) ***mengine (taja*** **.....**	

Annex 1(b)

CODE SHEET
MWONGOZO

THE IMPACT OF CLIMATE CHANGE ON FOREST LINKED RURAL LIVELIHOODS: THE CASE OF THE NORTH NGUU MOUNTAIN BLOCK IN KILINDI DISTRICT, TANZANIA

(MADHARA YA MABADILIKO YA TABIA NCHI KWA MAISHA YA VIJIJINI YANAYOTEGEMEA RASILIMALI MISTU HUSUSAN KWA ENEO LA MILIMA YA NGUU KATIKA WILAYA YA KILINDI, TANZANIA)

INTERVIEW QUESTIONNAIRE CODE SHEET
MWONGOZO WA DODOSO LA MAHOJIANO

CODE 0: Interviewee Identification
(Utambulisho wa mhojiwa)

01	Village *Kijiji*	Gombero	1
		Kilindi	2
		Kwediboma	3
		Lulago	4
02	Livelihood *Mfumo wa maisha*	Crop farming *(kilimo cha nafaka)*	1
		Agro-pastoralism *(ufugaji)*	2
		Other (mention) ***Nyingine (taja)***	3
03	Sex *Jinsi*	Male *(Mume)*	1
		Female *(Mke)*	2
04	Age *Umri*	Young *(Kijana)*	1
		Adult *(mtu wa makamo)*	2
		Elder *(mzee)*	3
05	Education *Kiwango cha elimu*	None *(hakusoma)*	1
		Literacy classes *(madarasa ya kisomo cha elimu ya watu wazima)*	2
		Primary education *(elimu ya msingi)*	3
		Secondary education *(elimu ya sekondari)*	4
		Post secondary education *(elimu zaidi ya sekondari)*	5

CODE A: Perception of communities on climate change
(uelewa / mtazamo wa jamii kuhusu mabadiliko ya tabia nchi)

A1	Climate change *Mabadiliko ya tabia nchi*	Changing rainfall (storm size and patterns) *(mabadiliko ya mvua)*	1
		Changing temperatures *(mabadiliko ya joto)*	2
		Changing livelihoods and hence income levels *maisha na kipato*	3
		Other (mention) ***Nyingine (taja)***	4
A2	Causes of changing weather conditions *sababu za mabadiliko ya hali ya hewa*	Pressure on the forest *(msukumo katika matumizi ya misitu)*	1
		Poverty *(umaskini)*	2
		Natural factors *(sababu za kiasili)*	3
		Other (mention) ***Nyingine (taja)***	4
A3	Early Warning Systems *Viashiria*	Rainfall (storm size) *Mvua (kiasi)*	1
		Drought *(ukame)*	2
		Changing temperatures *(mabadiliko ya viwango vya joto)*	3
		Other (mention) ***Nyingine (taja)***	4

CODE B: The impact of climate change on rural livelihoods
(Madhara ya mabadiliko ya tabia nchi kwa maisha ya vijijini)

B1	Earning living *(Mikakati ya maisha)*	Crop farming *(Kilimo cha nafaka)*	1
		Livestock keeping *(Ufugaji)*	2
		Trading (game meat, timber) *Biashara*	3
		Other (mention) ***Nyingine (taja)***	4
B2	Impact of climate change on living *(madhara)*	Land Use conflicts *(Migogoro ya matumizi ya ardhi)*	1
		Low production / productivity crop / livestock (*uzalishaji mdogo)*	2
		Land / forest degradation *(kudhoofika kwa raslimali ardhi / misitu)*	3
		Other (mention) ***Nyingine (taja)***	4
B3	Adaptation options *(Njia mbadala)*	Collection of the non-timber forest products *(kuokota mazao ya misitu si mbao)*	1
		Hunting *(kuwinda)*	2
		Moving to other areas *(kuhama)*	3
		Other (mention ***Nyingine (taja)***	4
B4	Challenges on adaptation options *(Changamoto)*	Insufficient capital assets *(mitaji midogo)*	1
		Insufficient policies *(sera na mipango dhaifu)*	2
		Insufficient technology adaptation *(mapungufu katika elimu na technologia sahihi)*	3
		Other (mention) ***Nyingine (taja)***	4

CODE C: Potential of the forest on rural livelihoods
(Umuhimu wa misitu kwa maisha ya vijijini)

C1	Potential of the forest on livelihoods *(umuhimu wa misitu katika mifumo ya maisha)*	Potential for tourism and recreation economy *(utalii na burudani)*	1
		Study potential *(masomo, tafiti)*	2
		No potential *(Hakuna umuhimu)*	3
		Other (mention) ***Nyingine (taja)***	4
C2	The impact of climate change on the forest *(madhara ya mabadiliko ya tabia nchi katika misitu)*	Pressure on the forest *(msukumo / msongo katika matumizi ya misitu)*	1
		Unsustainable forest production / productivity*(uzalishaji dhaifu wa misitu)*	2
		No impact *(hakuna umuhimu)*	3
		Other (mention) ***Nyingine (taja)***	4
C3	Sustaining the forest potential on livelihoods and adaptation options *(kuendeleza umuhimu wa misitu katika maisha)*	1. Develop Village Forest Management Plans *(mipango ya kuendeleza misitu ya kijiji)*	1
		2. Abide to existing forest regulation and enforcement *(kutekeleza mipango iliyopo inayofuatwa sasa)*	2
		3. Use of indigenous forest management *(fuata mipango ya kiasili ya kuendeleza misitu)*	3
		Other (mention) ***Nyingine (taja)***	4

Annex 2

FOCUS GROUP DISCUSSION
MIJADALA YA WAZI KATIKA VIKUNDI

THE IMPACT OF CLIMATE CHANGE ON FOREST LINKED RURAL LIVELIHOODS: THE CASE OF THE NORTH NGUU MOUNTAIN BLOCK IN KILINDI DISTRICT, TANZANIA

(MADHARA YA MABADILIKO YA TABIA NCHI KWA MAISHA YA VIJIJINI YANAYOTEGEMEA RASILIMALI MISTU HUSUSAN KWA ENEO LA MILIMA YA NGUU KATIKA WILAYA YA KILINDI, TANZANIA)

INTRODUCTION

1. Introduce yourself
   (Jitambulishe)
2. Introduce the study
   (Tambulisha lengo la utafiti na lengo la mijadala itakayofanyika)
3. Thank participants for accepting your invitation
   (Washukuru washiriki wote kwa kuitikia mwaliko)

Icebreaker Do you have anything about your living that you would like to share with us?
Anzisha mjadala: Je, unalo jambo lolote kuhusu maisha yako ambalo ungependa kutushirikisha sisi hapa?

QUESTION
(Swali)

What impact does climate change have to livelihoods in this village?
(Ni madhara gani katika maisha yanayotokana na mabadiliko ya tabia nchi katika kijiji hiki?)

DISCUSSION PROMPTS ***(Hoja za kujadiliana)***	**MAIN ISSUES** ***(Maswala muhimu)***
1. Factors / interests behind settling in the village / area *(sababu / mapendekezo ya kuamua kuishi katika kijiji / eneo hili)*	.....
2. Livelihoods mostly aff ected by climate change in the area *(Aina ya maisha ambayo yanaathiriwa zaidi na mabadiliko ya tabia nchi)*	.....
4. The impact of climate change on livelihoods *(Madhara / athari za mabadiliko ya tabia nchi katika harakati za maisha)*	.....
5. The impact of climate change on the forest *(Madhara / athari za mabadiliko ya tabia nchi katika misitu)*	.....
6. Forest support to adaptations (experiences) *(Umuhimu / uwezo wa misitu kama njia mbadala ya maisha – uzoefu)*	.....
7. Sustaining forest linked adaptation options *(kuendeleza utunzaji wa misitu kama njia mbadala ya maisha)*	.....

Annex 3

OBSERVATION CHECK-LIST

THE IMPACT OF CLIMATE CHANGE ON FOREST LINKED RURAL LIVELIHOODS: THE CASE OF THE NORTH NGUU MOUNTAIN BLOCK IN KILINDI DISTRICT, TANZANIA

Observing the impact of climate change to rural livelihoods with a strong bearing at the North Nguu Mountain block forest base adaptation options.

Village	Session 1	Session 2
Kwediboma		
Kilindi		
Gombero		
Lulago		

		Existing	Non-existing	Operational	Non-operational	New	Old	Potential	Weak / poor	High	Low	Moderate	Owned by insider	Owned by outsIder	I ndividual owned	Family owned	Group / company owned
1	**Options for livelihood diversification**																
	Crop farms																
	Cattle herds, goats, sheep																
	Other																
2	**Adaptation options / livelihood strategies**																
	Business Enterprises (forestry)																
	Processing plants (forest related)																
	Other																
3	**Potential for adaptation / livelihood strategies.** NOTE: Aspects that need laboratory tests or scientific research not observed.																
	Ecosystem goods and services																
	Water catchment																
	Timber																
	Fuel wood																
	Traditional / local medicine																
	Wild fruits and vegetable																
	Other																

Annex 4

SECONDARY DATA PROFILE

THE IMPACT OF CLIMATE CHANGE ON FOREST LINKED RURAL LIVELIHOODS: THE CASE OF THE NORTH NGUU MOUNTAIN BLOCK IN KILINDI DISTRICT, TANZANIA

The necessary information to verify / complement primary data.

	DATA SOURCE					
	Village / Ward	District / Region	Meteorology Department	Forest Division	IPCC Webpage	Imagery
Rainfall / Temperature (Trends and Measurements)	V	V	V			
Forest (Strength, Opportunities, Weaknesses, Threats)	V	V		V	V	V
Livelihood (Zoning, Diversification)	V	V			V	
In / Out Migration (Cause-Effect)	V	V			V	
Early Warning Systems (Indigenous, Contemporary)	V	V	V	V	V	
Adaptation options (Indigenous, Contemporary)	V	V			V	
Vegetation Cover (Before / After villagilization)	V	V		V	V	V

Data type

Source	Nature
Village	Village meetings minutes specific on livelihoods / forest issues..
Ward	Ward Development Council meetings minutes on livelihoods / forest issues.
District	Sectoral Reports: Forest, Community Development, Agriculture & Livestock
Region	Sectoral Reports: Forest, Community Development, Agriculture & Livestock
Ministry	Sectoral Reports: Forest, Community Development, Agriculture & Livestock
TMA	Area specific rainfall data – Study area.
IPCC Web	Related studies: Climate change/The forest specific from the study area

Appendix 5

RAINFALL DATA

KILINDI PRIMARY SCHOOL
TOTAL MONTHLY RAINFALL

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1994	m	m	m	m	m	m	m	m	m	m	m	87.6
1998	523.6	514.8	336.3	120.2	62.6	17.7	31.1	6.3	14.1	m	m	m
2001	117.9	0	24.9	m	m	m	m	m	m	m	m	m
2002	m	m	m	m	m	m	m	m	m	143.9	50.3	m
2003	m	m	m	m	m	m	27.2	m	m	m	m	m
2007	m	m	m	m	m	m	m	m	m	m	80.9	240.2
2008	74.7	m	182.6	m	61.6	51.7	40.5	15.8	15.1	m	m	m

KWEDIBOMA
TOTAL MONTHLY RAINFALL

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1976	m	m	m	m	m	17.1	6.7	1.4	23.0	8.6	10.2	37.4
1977	74.3	116.1	m	39.1	5.6	m	m	m	m	m	m	m
1979	m	78.0	127.2	235.0	60.3	76.3	0.0	4.6	7.9	3.2	25.0	78.7
1980	114.8	31.1	97.4	158.1	94.8	0.0	2.5	28.1	0.0	0.0	101.3	77.1
1981	40.5	59.3	140.4	295.0	117.5	0.0	0.0	8.2	26.2	40.0	14.4	110.6
1982	0.0	14.2	101.5	153.0	65.9	76.8	69.1	12.3	11.4	163.8	155.8	0.0
1983	38.9	46.4	55.5	56.5	98.6	21.8	0.0	0.0	0.0	0.0	85.7	287.8
1984	233.9	25.6	0.0	182.9	103.2	39.4	0.0	0.0	15.4	46.7	76.8	108.6
1985	11.0	191.4	7.2	73.3	95.3	0.0	0.0	0.0	0.0	38.2	83.1	66.6
1986	123.0	81.8	147.8	84.0	84.0	1.6	0.0	6.2	0.0	15.9	81.5	306.6
1987	78.0	91.0	49.3	81.2	84.5	0.0	0.0	0.0	0.0	2.2	35.1	13.2
1988	114.5	37.9	115.0	22.8	0.0	18.7	0.0	30.6	5.6	27.2	8.7	188.2
1989	280.0	51.0	69.7	157.2	99.9	33.9	0.0	3.9	17.9	41.3	68.6	117.2
1990	71.2	99.3	268.2	191.2	21.3	12.5	0.0	0.0	4.2	10.4	49.5	62.2
1991	133.3	35.9	25.6	68.6	71.0	0.0	14.0	18.5	3.3	0.0	34.2	167.2
1992	34.2	141.4	70.6	171.7	61.7	8.5	0.0	1.6	0.0	0.0	97.8	91.2
1993	63.8	88.7	49.7	95.3	52.2	10.7	3.8	11.9	0.0	33.8	14.7	0.0
1994	96.1	71.3	146.8	39.9	67.8	3.7	10.2	3.6	12.1	30.4	17.4	140.1
1995	22.3	117.4	66.7	72.6	89.9	0.0	1.3	34.1	0.0	23.5	4.6	57.8
1998	184.1	89.7	91.5	m	52.4	0.0	18.9	0.0	5.2	2.0	10.7	26.8
1999	89.7	7.6	m	m	65.6	31.3	25.4	m	m	m	59.6	32.7
2000	50.5	13.0	97.6	m	m	18.8	6.0	12.8	4.3	0.0	53.4	204.6
2001	m	m	m	m	m	m	4.4	m	0.0	m	0.0	40.2
2002	65.9	64.7	42.8	m	m	m	m	m	m	m	m	m
2007	m	m	m	m	m	m	m	m	m	m	m	16.0
2008	69.0	94.7	375.0	m	77.0	m	m	0.0	m	m	m	m
2009	m	196.7	23.3	m	m	m	0.0	4.5	6.0	27.9	m	259.5
2010	376.3	50.4	67.3	124.0	48.0	0.0	0.0	0.0	0.0	0.0	0.0	m
2011	84.3	89.2	361.1	160.0	290.0	23.5	0.0	4.5	175.5	147.0	39.0	36.0

m = missing value

FOR: DIRECTOR GENERAL
MINISTRY OF TRANSPORT
TANZANIA METEROLOGICAL AGENCY
P. O. Box 3056
DAR-ES-SALAAM

Masoud
28/9/2012